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Plastics

Dealing with the Manufacture, Uses and Potentialities of Plastic Materials

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Ford's New Child

WHILE British manufacturers have been telling us (a) that the plastic car body is quite impossible, (b) that they could not afford to make it even if it were possible, Mr. Henry Ford has gone ahead and has produced one—and what a beauty!

The photograph we publish on another page is probably the first to appear in this country, and for it and the notes that accompany it we have to thank Mr. H. W. Perry, a well-known American journalist-engineer.

The data he gives are startling, for he mentions the fact that the ¼-in. plastic panels " have 10 times the impact strength of mild-steel sheets normally used for body panels." There are two points to note here; first that the sheet normally used is probably between 1/20-1/30-in. thick, so that the plastic is from five to seven times thicker, and secondly that the plastic must be a very special one, itself of very high impact strength. While we have no real knowledge on this point we should like to take an even-money bet that the process is one we have often insisted would make the strongest plastics of the phenol-formaldehyde type. We have often urged, in these pages, the adoption of paper-making technique and the use of resin emulsions. We believe that Mr. Ford has employed such a process, putting his fibres in a paper-beater and impregnating them with resin, by saturating them in an emulsion. After removal of the excess emulsion, the " pulp " is cast into a pre-form, when the continuous phase of water is entirely removed. Finally curing and consolidation is carried out on a very large press in the usual way.

Obviously the new car has been lacquer-sprayed in the same way that steel cars are decorated. While this will be a disappointment to those who lay such great stress on the fact that plastics need not be painted, it is a small point at present. The future developments will probably take care of that.

Mr. Perry states that the new step is not a hurried attempt to replace steel during the present shortage. This we well believe, but it is nevertheless a most fortunate piece of research work, and worthy of our sincere praise.

In this country the motorcar industry has not spent 6d. on real plastic research. This is, no doubt, a direct result of the virtual subsidy the British industry received and enabled it to " sit pretty." What a farce this all is. Instead of being a mere five years behind the times, Britain is now 10 years behind. And it's no good blaming the war.

What Mr. Ford is most pleased about, we should say, is the fact that agriculture will take its rightful place in industry, in a country where agriculture has had even a worse deal than in this. We are inclined to ask what attitude will governments take up in view of the industrial revolution that is taking place under their very noses?

What Scotland Does To-day

THE Scots have got a strange habit of tackling first things first, and houses and homes will be among the most important of things to get into order when we find peace with us. The experimental plastic house is to be built in Scotland.

The work and experiments of Building Plastics Research Corporation, Ltd., into the use of plastic resinous materials for building purposes has been brought to the notice of the Scottish Special Housing Association, Ltd. This body was formed to assist Scottish Local Authorities to provide houses by methods alternative to brick and stone. The Association has decided to ask the approval of the Government to take immediate action to test the suitability of these new materials and their form of construction by erecting an experimental house. This is indeed a welcome move.

The proposed house will make use of thermosetting and thermoplastic materials for the entire structural framing, stanchions, purlins, walling (externally and internally), floor slabs, window frames, stairs, doors, door-frames, roof sheeting, etc.

The aim is to achieve prefabrication in the factory to the *n*th degree. It may even be possible to fabricate, in one complete unit, the entire bathroom or kitchen or staircase, including walls, floor, roof and all pipes and fitments in position, the whole assembly to be transported directly to the

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building site and placed in position. Similarly, entire walls, with windows and doors already in position and finished decorative surfaces externally and internally, may be brought on to the site and merely placed in position. Plastic materials are so light in weight that it is inevitable that this advantage will be exploited fully by designing for complete prefabrication.

While this is one of the ultimate aims of the designers, the actual form of the proposed house is still under consideration. Details will be published in due course.

On page 188 of this issue we are glad to publish the views of a distinguished Scottish architect, Mr. T. Warnett Kennedy, himself a member of the Building Plastics Research Corporation, Ltd., on the materials of the plastics industry and how they can affect building. His views—and this article is the forerunner of a series—are extremely critical, and since they are given by a practical worker with a discerning knowledge of plastics they should be read with care by all plastic technologists.

We in the industry have been groping our way in the dark in many fields of which architecture is one. Here, however, is a strong guiding hand to lead up to the light. We should do well to hold on to it.

WHAT IS GLASS?—One of the sad things about the plastics industry is an almost total lack of clear nomenclature. The industry itself does not like the word "plastics" which really covers many substances which are plastic and which we do not make or work, and words such as "resinoids," "phenoplasts," and so on, do not thrill us or the general public to the core. The situation is more than annoying and can assume a serious aspect. We have only to look at the trouble the artificial silk industry got into before it thought of the word rayon. Du Pont's were very sensible when they pushed forward the word nylon to cover their new fibre.

The latest bit of trouble is brewing with organic glass. A first-class row is now taking place in America over the inroads transparent synthetic resins and other sheets are making into the glass market, and glass manufacturers are objecting to the use of the term organic glass. Indeed, the Federal Trade Commission has taken out a suit against S. Buchsbaum and Co., Chicago, to determine whether plastic products with "glassy" names are being sold unfairly in competition with glass. Already several hearings have taken place and two witnesses have already been questioned as to the definition of glass. These witnesses, Dr. Hosteller of the Hartford Empire Co., and Dr. Ryan of the Libbey-Owens-Ford Glass Co., limit their definitions of glass to inorganic products as we suppose they would do. Presumably plastics experts will also be given a chance. We think if the defendants were sensible they would also get the help of a few lexicographers.

We like arguing on this type of subject, although one gets nowhere, the only result being that the lawyers make a lot of money and the public still call the stuff what it wants to, whatever the legal result.

However, to delve into the matter for a moment, and it is important since the same type of action might take place here, let us see what the word glass means. It is a very old one and the Anglo-Saxon, Icelander and very low German knew it under "glæs" or "glas" or "gler." To them it meant something that glistened and they probably used it for odd things they saw on the ground such as pyrites and other ores (hence the word "glance" still used in mineralogy), flint and shining sand. They probably gave this name to anything that shone, for example, to polished metal which might have been used as mirrors by the lovely ladies of the time. In fact, as glass made by the fusion of sand and soda did not come to the western world until comparatively late, it is very likely that what we moderns term glass really usurped the name from previous objects called glass.

It is true that a type of glass vessel was made in Egypt about 1500 B.C., but real progress only began during the beginning of the Christian Era. Europe probably had no glass works until the end of the first century A.D.

However, the manufacturers of organic glasses may prefer to get ready against the day and prepare a few fancy names. Perspex, the I.C.I. material, has started out on the right foot.

A COLD-SETTING CEMENT.—With all the praise we have lavished on phenolic and urea-formaldehyde glues, on their great strength, their resistance to moisture and bacteria, in fact on all the great advantages they have and which have virtually ousted animal and vegetable glues from high-class work, there is one drawback which is generally omitted. Indeed, so great are the advantages that the technique of glueing has been altered for their accommodation. The drawback we refer to is, of course, obvious to the plywood manufacturer—the fact that until recently hardening had to be carried out under high temperature in addition to pressure. This fact, of course, was responsible for the slow development of synthetic glues among the smaller fry. It was only the larger concerns that could quickly adopt the type of presses needed.

The well-known makers of cast resin, Catalin, Ltd., have now produced a new type of phenolic resin, Catacol, a true cold-setting cement which will harden at room temperature and only needs sufficient pressure to keep contact between the surfaces to be stuck. Like other synthetic types it gives high water- and fungi-resisting joints, and wood glued with it can be boiled for hours without any ill effect. As with other glues, a hardener is added before use, the time of hardening being proportionate to the quantity of this catalyst added and the temperature employed. It will be readily understood that Catacol can be also used as a hot-setting cement and so conforms admirably with any type of process that it is desired to employ. Tests carried out on this glue by the Forests Products Research Laboratory indicate that it has very great strength. It has been approved by the Ministry of Aircraft Production under specifications 5V3, D.T.D. 427, 335 and 335A. Its use is noted in boat-building in an article on page 196.

LEND-LEASE MATERIALS.—As the result of discussions which have taken place between Ministers and the United States Ambassador, correspondence has been exchanged and laid before Parliament as a White Paper setting out the principles which should govern the use and distribution of Lend-Lease materials in this country.

As United States export trade is being impeded by restrictions imposed by the United States Government upon the supply of raw materials needed for defence purposes, and as such materials are being supplied to us under the Lend-Lease Act, H.M. Government are under the obligation to take steps to secure that no advantage is thereby enjoyed by United Kingdom manufacturers for export over their United States competitors. It would not be tolerable that we should use, for the purpose of maintaining our export trade, still less of expanding it at the expense of United States exporters, material of which the United States exporter had been deprived in order that that material should be made available for our defence. H.M. Government has therefore offered to the United States Government the undertaking in the White Paper.

The whole situation requires sympathetic understanding on both sides. There will be full co-operation no doubt. It may be noted, however, that, because of labour and raw-material shortage here, it would appear that our exports cannot assume great dimensions, and in part exports to the U.S.A. are merely replacing exports from Europe. With the cessation of the latter there is also ample room for development in S. America and elsewhere.

Mr. Henry Ford creates a new era in motorcar manufacture and brings a new hope to American agriculture

By
H. W. PERRY

The First Plastic Automobile Body

PERHAPS as soon as next year the often-predicted plastic motorcar may be made available to the public. It will be a third lighter than its steel counterpart and therefore very likely will be driven by an engine of about 60 h.p. American rating, yet the body will be stronger and safer than present steel bodies, as the ¼-in. plastic panels have 10 times the impact strength of mild steel sheets used for body panels and fenders, or mudguards.

The commercial advent of such a car has been brought much nearer realization by the completion of the first plastic model of a two-door sedan by the Ford Motor Co. after a dozen years of plastics research by the company chemical and mechanical engineers. This model, shown in the accompanying engraving, was viewed by several hundred residents during the celebration of Dearborn Day last August 13 in the Michigan community made known the world over by the Ford company.

Although officials of the company emphasized that it is only an experimental model and its production for sale is still a long way in the future, the further authoritative statement that the standard power plant to be used in the new model has yet to be decided upon is sufficient ground for assumption that the company definitely plans to put it in production, probably within a year.

The new body is not a hurried attempt to substitute plastics for steel in automobiles to maintain motorcar production during the metal shortage created by demands of the war-aid and national defence effort. It is a development that has been under way for a dozen years to take advantage of the several distinctive properties of certain plastics suited to the purpose and to further Mr. Ford's programme of more closely uniting industry and agriculture.

The entire body structure is built of 14 plastic panels mounted on a frame of steel tubing, and the windows and windshield are glazed with a clear, transparent plastic material of the same composition used for hoods over cockpit and gunner stations on military aircraft. Ordinary farm and forest products constitute the body-panel plastic, which is formed of a mixture of synthetic resin and the cellulose fibres of such materials as wheat straw, flax, hemp, ramie and spruce wood. After mixing, the plastic compound is formed into approximate panel shape in a vacuum-operated press and then given final exact, permanent form under heat and a pressure of 1,500 lb./sq. in. in a mould, from which the panels emerge with a thickness of only ¼ in. but declared by Ford engineers to have an impact strength ten times greater than that of the usual steel panels.

An important result obtained with the plastic body is a decrease in weight of the initial car model to about 2,000 lb. as against the approximate 3,000 lb. of the conventional steel car of equivalent size. Weight of the entire superstructure is only about 500 lb., of which the steel frame comprises one-half. This weight reduction will enable the use of a correspondingly lighter, lower-powered engine without sacrifice of acceleration and speed, and the user will benefit from reduced fuel and oil consumption and lower licence and taxation costs.

Selling price of the eventual production car probably will be at least as low as that of the conventional all-steel car of similar size and model, for the fewer fabricating and finishing operations required by the plastic bodies are expected to result in manufacturing savings that will offset perhaps higher prices paid for the raw materials than for steel sheets. Mr. Ford, seen at the extreme right in the picture, said he was confident that plastic bodies can be produced by practical and economical means, and he is prepared to prove it to those who have insisted that they never can compete on a cost basis with steel bodies.

Attractiveness of appearance need not be diminished by plastic construction, as the photograph of this first model of a two-door sedan with plastic body shows that it is not radically different from the present corresponding Ford steel model. The contours are as well streamlined but there are fewer deep draws, particularly in the fenders, or mudguards, integral with the body.

Plastics and the Architect

NEW OBJECTIVES FOR THE PLASTICS INDUSTRY

In publishing these notes from a distinguished architect, we and the plastics industry as a whole are very much aware of our lack of knowledge of what the builder really requires and what the architect hopes to achieve with our materials. The author's criticisms are more than welcome, for they are both constructive and informative. When we get the co-operation Mr. Kennedy seeks, the prospect for Great Britain will be bright

By
T. WARNETT KENNEDY,
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RESEARCH on plastic materials and special processes for use in connection with the building industry has always been retarded by lack of certainty on the part of plastic technicians as to the precise needs and special problems of architects and builders. The field of building is wide and complex and it has been nobody's business to isolate the problems and pose them in a manner intelligible to the plastics industry. Any attempt, therefore, as in this article, to discuss the limitations of plastic materials and techniques to date, inasmuch as they can be applied to building, may have the effect of stimulating new researches or inducing some plastics manufacturer to take the initiative in the field of building.

Extrusion Materials

One can readily appreciate that the importance of length, when considering building components, cannot be over-estimated. It is vital, therefore, that extrusion techniques and materials be substantially improved if they are to find their proper use in building. Frankly, the materials of synthetic nature which can be extruded are too brittle and lack the necessary strength for direct application to building. There are many small parts of a building structure where the mechanical strains are small or non-existent and a reasonably strong extrusion would prove useful. For instance, roof glazing bars; window astragals; cover strips for wall sheeting; mouldings for picture rails, dadoes, skirtings, architraves, cornices, etc.; rainwater conductors; roller-shutter laths.

The strength of an extruded material is no doubt largely determined by the nature of the "filler." This is, in turn, complicated by the necessity of obtaining easy flow through the nozzle of an extrusion die. It is doubtful if a fibrous filler could be made to flow, and it is upon the fibrous interlocking that the strength, especially the impact resistance, largely depends. One can readily appreciate the unsuitability of powdered fillers and their inability to withstand a torsion test. The machining properties are also of extreme importance, and while powder-filler extrusions may be cut by suitable tools with comparative ease, it would, perhaps, be more difficult to commend their nail-holding properties, and one gets the impression that a tendency to fracture at sharp edges, where, for instance, screw-nails are necessary, would complicate fabrication.

Again, it would be interesting to know what possibilities exist of reinforcing extruded sections other than with fillers. Progress would be achieved if a method could be devised of providing a metal- or wood-insert reinforcement during the actual process of extrusion, perhaps in the form of a central core moving through the die simultaneously with the plastic composition.

Where extruded components are exposed in the building structure under conditions where dimensional change is likely to occur through variations of temperature or conditions of humidity, or where weather resistance generally is called for, the choice of material is necessarily limited. Many thermo-plastics otherwise attractive from the point of view of colour and ease of manufacture may be ruled out on this account. The indications are that suitable extrusions for building are more likely to follow from developments connected with the extrusion of thermo-setting compounds owing to the superior dimensional stability and mechanical strengths of phenol-formaldehyde products. Conversely, the colour limitations of the phenolics would be a serious drawback, and with urea-formaldehyde compounds the weather resistance is hardly good enough to compensate for their splendid colour range.

The factors which control the cost of extrusions are necessarily obscure to the architect at present. The data available, however, indicate that, while a lowering of consumer's cost is necessary, the margin of difference between present-day prices and competitive prices for conventional materials is not great. A frank discussion between plastics manufacturer and the research architect would enable the design to be amended to meet such difficulties. Further economies would naturally follow, from intense rationalization of plant and production methods, to meet conditions of real mass production. Splendid new markets are thus awaiting the plastics manufacturer who is willing to devote reasonable energy to overcoming the architect's difficulties. That these difficulties are not ultimate "stoppers" is apparent, and it is encouraging to know that the gap to be bridged is so small and the rewards of success so large.

Structural Sections

The fabrication of lightweight building sections, such as beams, stanchions, purlins, angles, channels, etc., present difficulties which many people have, until now, considered unsurmountable. The problem of obtaining the necessary lengths of sections at first suggests processes of extrusion. These can be ruled out for a long time to come for the reasons set out in the first part of this discussion. The mechanical strengths necessary for even small-span buildings are so high as to preclude extrusions, but pressure moulding is quite adequate to the task, provided certain adaptations of plant can be effected to cover lengths up to, say, 15 ft. Such adaptations, however, require careful consideration if even pressure along this entire length has to be maintained, and careful control of temperature is equally necessary to control the time of curing. If the equipment is unsuitable or the operation is not thus controlled, a tendency to warp will probably manifest itself. Progress will undoubtedly follow from success in overcoming

these difficulties, which, while apparently simple, nevertheless present the plastics technician with innumerable unforeseen snags.

The Place of Thermosetting Resins

The thermosetting phenolics are again the obvious choice when choosing suitable materials, both on account of mechanical strength and dimensional stability. It is, however, on the nature of the filler reinforcement that real strength so largely depends. A highly laminated section will, without doubt, meet the case, but the complexity of the operations and time taken in the building-up process is reflected in costs, making the resultant section only of interest as a laboratory specimen.

It should be realized that neither colour nor finish is of the slightest importance when building up a structural section, which, when erected in the building structure, is covered up by the wall sheeting, and only mild-steel platens need be employed in the moulding operations. Cheaper moulds may be on the way and will help to make the product a better commercial proposition.

Possibilities of Prefabrication

Various factors, outside the actual manufacture of structural sections, materially affect the commercial possibilities. The strength-to-weight ratio of plastic components is quite remarkable and the building industry is almost completely unaware of the facts. Factory prefabrication of light structures has always been retarded by the weight of assembled units and the difficulty of transporting and erecting heavy units. Plastic structures, however, make an enormous contribution towards achieving this ideal on account of their extreme lightness alone, and the facility of handling should lead to very substantial economies in ultimate building costs. It may well be, therefore, that, while a straight comparison between any single plastic component and one made from timber or steel may show the plastic part to be dearer, the unseen factors of speed and full prefabrication will more than balance the ultimate cost to the client. Even within the structure itself economy of cross-section of a component can be achieved owing to the lesser loads of floors and roof. The advantages of mass production and consequent rationalization again come into operation to reduce overheads.

Colours and High Gloss are Not Always Desired

The plastics industry has been hypnotized by the ease with which it can obtain exceedingly high finish to its products. It is, of course, natural that this advantage should have been exploited to the full, but when considering finishes for the building industry the æsthetic outlook associated with architectural design is quite different and high, glossy finishes are invariably associated with the wall lining of bathrooms, kitchens or shop fronts. The architect, the builder, and usually the home owner, are in love with dull or matt surfaces and intriguing textures. Architectural taste in these connections has been formed by association of ideas over the course of centuries and has been acquired through the constant use of stone, brick, concrete and innumerable methods of cement rendering. In the case of modern architecture, the tendency towards functional design may lead to large expanses of unbroken wall surfaces, and in the absence of alternative design elements, such as the fenestration or entrances, etc., the tendency has been to rely upon rich texture to give an impression of quality to a surface which might otherwise appear bald and uninteresting. It is surely possible, therefore, and clearly worth while, for the plastic industry to produce a range of finishes which have the textural qualities required. Essential cleanliness of plastic surfaces need hardly be sacrificed to achieve this end owing to the high resistance to moisture penetration and chemical corrosion which characterizes these materials, but which have been a bugbear to the designer using well-known materials. Until such products are available plastic sheeting for building will make little headway against these deeply rooted prejudices.

The Application of Utilitarian Surfaces

A further profitable line of research would be that of obtaining utilitarian finishes to plastic surfaces as would be vitally necessary in the case of a floor slab or stair tread, which must have a suitable hard-wearing, non-skid surface in itself and should not require further pressing or applied treatment. Components of this nature must have all the qualities necessary to permit constant traffic over floors and stairs without appreciable deterioration.

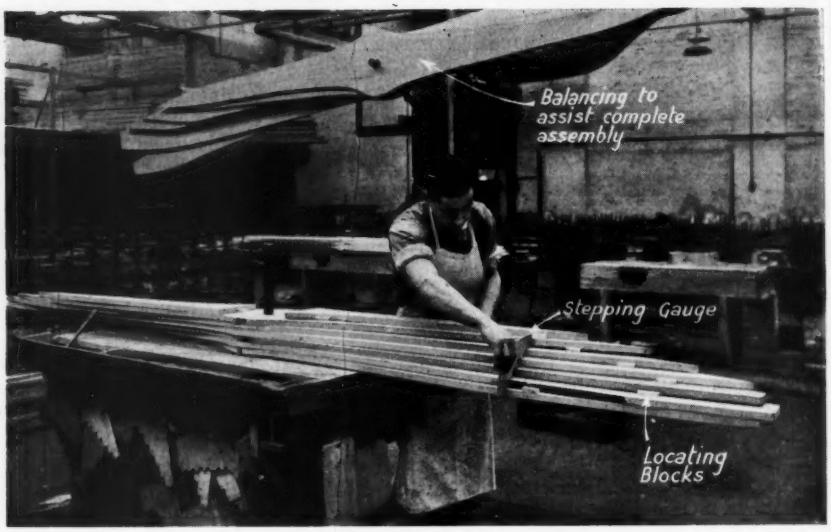
From the cost point of view, these components should be finished products in themselves, not only to effect complete prefabrication, but to avoid an extra charge for an applied finish.

The range of colours obtainable by the use of plastic materials is apparently unlimited and, indeed, the idea of colour is almost synonymous with the idea of plastics in the mind of the general public. When one examines the colours available, however, having in mind the wishes of the architect or artist designer, it is surprising how the field becomes limited. The reason would appear to be that most colours used by the plastics industry are too near the primaries, and it is difficult to obtain a wide range of the more subtle or pastel shades. In this connection, of course, the high, glossy finish before referred to is most misleading. A glossy material with high reflection is apt to give the impression of primary colours, when in actual fact the shade may be more well considered than it would at first appear.

These criticisms may be thought comparatively irrelevant when compared with the much more formidable problems of introducing plastic structural and other parts into building, but it is an irrational fact that the general public, and even building technicians, who ought to know better, are blinded by their own subconscious æsthetic prejudices, and in the absence of a finish which is designed to catch the eye quite often fail to discern the significance of the real technical advances which have preceded the production of even the simplest components.

The Advent of New Conceptions

The introduction of new materials to replace known elements for house building and other types of light structures invariably start by more or less copying existing forms and profiles, and the preliminary comparisons seldom justify the high hopes of the innovators, but as the qualities inherent in the new materials become more widely understood the ingenuity of designers tends to develop new forms and exploit new techniques with vastly different ultimate effects. It is, perhaps, asking too much to predict what these ultimate forms will be or to foresee the evolution of plastic building, but it is already apparent that they will depart more and more from traditional conceptions and open up for society a new era of light, colour, cleanliness and convenience.



Assemblage of laminæ prior to glueing.

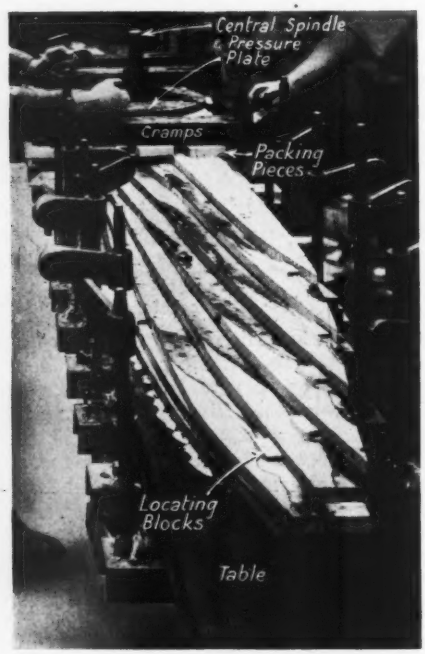
Making A MODERN AIRSCREW

THE discovery of the trick of driving through the air by cutting through it with a screw is now old history, but the type of screw has changed with the times and with our increased knowledge of the raw materials we possess.

At first airscrews were carved from the solid timber, a method not only expensive of labour and material, but restricted because of the difficulty of obtaining large sizes and of ensuring quality throughout the bulk. Even the best type warped. Metal types are now used, but of the greatest interest is the wide adoption of the laminated form of construction utilizing wood of special quality and treatment.

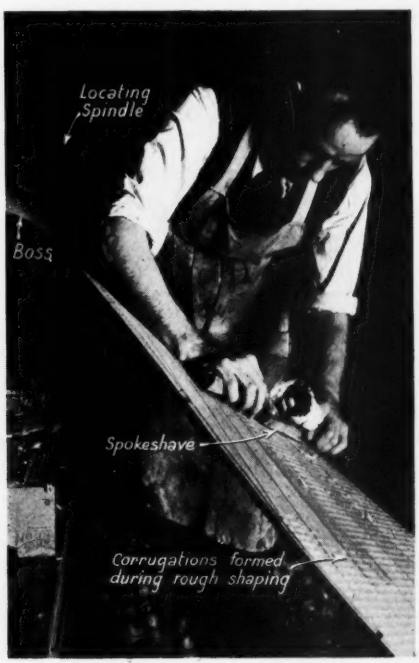
It has been said that the workmanship in the British aeroplane is the prime cause of our air superiority. Development of the airscrew and the adoption of synthetic resin and glues of high merit undoubtedly play their part

Wood as such is already an ideal material for the work. It has a high strength to weight ratio, and, in fact, its ratio of fatigue strength to weight is superior to



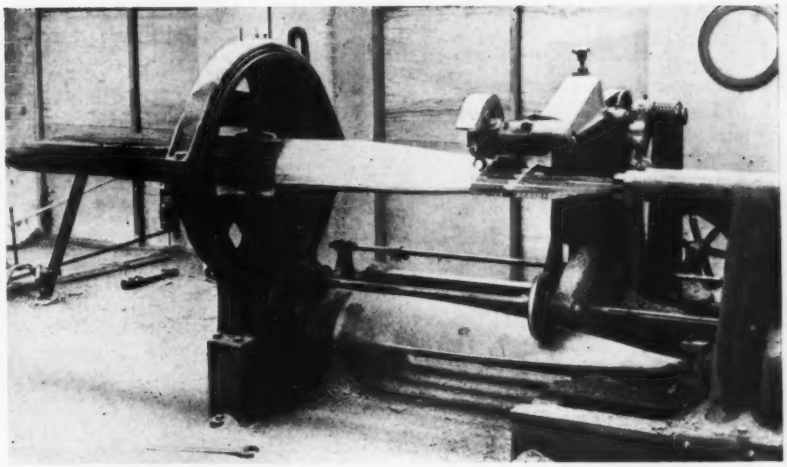
(Left) "En bloc" glueing in cramps. Note positioning by locating blocks.

(Right) Final shaping by hand-tool "in the white."



other airscrew materials. Its facility for internal damping (high hysteresis) makes it eminently suitable to resist the torsional fluctuations exerted upon it by the changes of engine running. Failure due to vibration is unknown.

But wood does not resist erosion well and it absorbs and exhales moisture. The modern techniques overcome all these drawbacks. The methods adopted by the Airscrew Co., Ltd., eliminate any inherent disadvantages and exemplify to what perfections the modern airscrew can be brought.



(Above) Automatic shaping machine. Note method of working from model airscrew beneath the machine proper

The procedure of construction as normally carried out is as follows:—

From the outlines of the various laminations required, templates are prepared and the boards are marked and cut accordingly. The boards are thicknessed to about ¼ in.

For the fixed-type or integral airscrew the laminations are first bored to fit a standard spindle of 1½ ins. diameter. They are then loosely assembled on the balance and arranged to give correct balance. Glueing is carried out on the first plank, which is firmly located on the central spindle, and then the second lamination is fitted on top, its correct position being fixed by a locating block. All the laminations follow in their respective positions. The glues may be casein or phenol-formaldehyde types. Cold-setting glues of the latter type seem indicated for future use. Such cements, as is shown elsewhere in this issue, are now commercially available. Their use will doubtless facilitate production.

Clamps are fitted about 10 ins. apart, the pressure being not less than 200 lb. per sq. in. After about 24 hours the clamps are removed, the boss faces are

(Above and below) Two finishing operations for the examination of pitch, using profile gauges, etc., on variable and fixed-pitch screws.

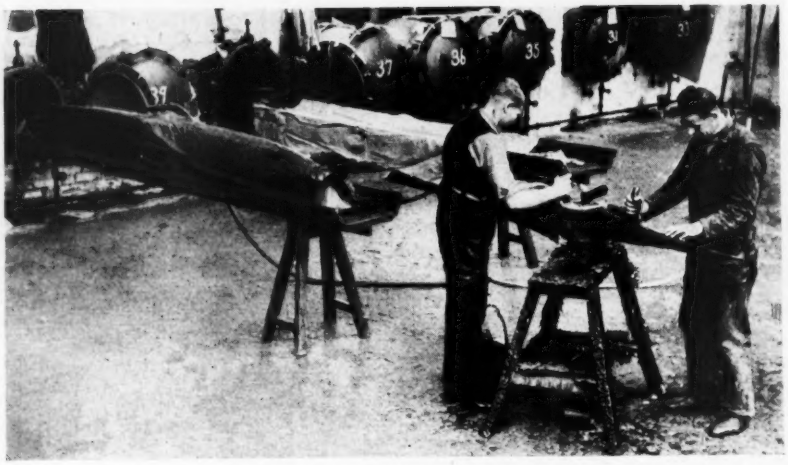
Here both fixed-pitch integral-type blades and the single detachable type for variable pitch are produced in large numbers.

The wood most widely used for fixed-pitch blades is Central American mahogany with a density of 34 lb. per cubic foot, and is supplied in large planks.

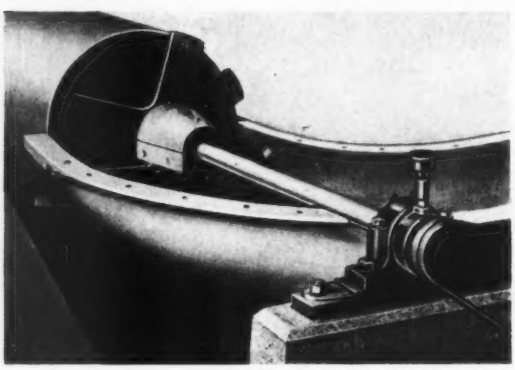
The seasoning is scientifically controlled in conditioning kilns, the moisture content being held at about 12-14 per cent. Preliminary tests, which include impact strength, end-grain compression strength, Young's modulus of elasticity and modulus of rupture, are carried out on all woods selected for the job.

tried, the central bore is accurately machined, and the blades are rough-shaped. This is carried out on automatic shaping or copying machines, and is followed by a final shaping by hand with spokeshaves and scrapers. The correct pitch is obtained by working to profile gauges at various points along the blade.

With the advent of high-speed aircraft the individual blade for variable-pitch airscrews has entered the picture, the pitch being varied by a controlling mechanism in the steel hub. The whole structure necessitates the perfect attachment of a steel shoe to the root of the blade and the insurance of extremely high shear strength of the wooden blade itself.



(Above) Covering of airscrews with cellulose acetate by the Schwarz process. Note autoclaves in rear.



(Left) For industrial application. Fan for removing gases, covered with polyvinyl chloride sheet.

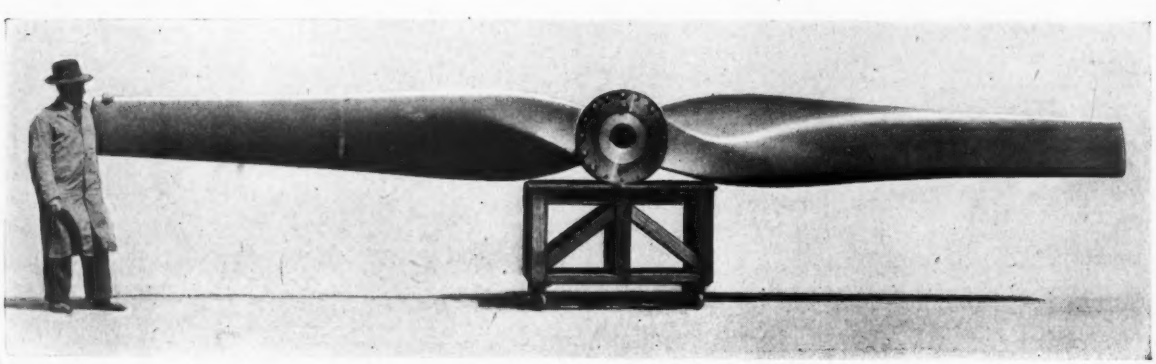
To realize this latter ideal the Airscrew Co., Ltd., has for some years now developed the Samsonow process of production of a highly compressed wood for the formation of the root. For this purpose resin-coated veneers are compressed at a pressure of about 3,000 lb. per sq. in. to produce an extremely dense and stable substance of the following characteristics:—

Tensile strength	...	47,000 lb. per sq. in.
Shear strength ...	...	7,400 lb. per sq. in. (along the grain)
Compression strength	...	26,500 lb. per sq. in.
Density	...	85 lb. per cubic ft.
Modulus of elasticity	...	4 to 4.5 by 10
Impact (Izod) ...	...	13.6

As indicated previously, wood wears badly from erosion due to sand, etc., and a protective shell is necessary for the blade tips. The company has developed the well-known Schwarz process of forming a cover of reinforced cellulose acetate over the surface of the airscrew. This consists, in the main, of making holes along the surface to act as keys, covering with sheet cellulose acetate and encasing the screw in a rubber pressure bag. The whole is then inserted into an autoclave, which supplies heat and pressure, so that finally the airscrew is covered with an immovable coherent sheathing of acetate. Fitted in this manner, airscrews frequently have a working life of over 3,000 flying hours.

Industrial Fans

From the aeroplane screw to the industrial fan is but a step, and in this sphere of activity the Airscrew Co., Ltd., have cut an important swathe in the science of air supply or air removal. The importance of such structures is obvious in chemical works, collieries and other industrial buildings. It is interesting to note that in one of the accompanying photographs—that of a fan extracting acid fumes—the blades are covered with polyvinyl chloride sheet. From the point of view of size, it is noteworthy that the large fan shown below is for a cooling tower and is 24 ft. in diameter.



A large fan for duty in a cooling-tower system.

Ideas—

By the EDITOR

Guess What This Is

Boys, do the Americans know how to put across an advertisement? I'll say they do! The accompanying photograph shows somewhere between the lady's hands and due south of her lips a gossamer of crimson cloth sheathed in a tube of matching hue—the Hanky-Saver. After use, a pull of the tassel and the hanky is drawn back out of sight. Although you may not realize it, the most important part of the photograph is the plastic tube made of Fibestos, Monsanto's cellulose acetate.

The picture is not an advertisement for eye-shade, nor

tooth-paste, nor nail-polish, but it is with the utmost reluctance that I tear myself from looking anywhere but at the lady's eyes or teeth. Can you blame me? Still, you're not playing the game, Monsanto!

We British, of course, always play the game. We'd make a cut-out showing only the tube plus hanky, and make a real technical job of it. I wonder which method sells more hankies. Truth to tell, I don't wonder.

Oliver Stewart's Idea

Major Oliver Stewart, who was one of our brightest fighter pilots in the last war and the most popular officer of a big testing station at which I played noughts and crosses, knows a good deal about plastics—he is a careful and regular reader of this journal. Nowadays he runs a brilliant monthly called "Aeronautics" and also contributes on air matters to "The Tatler." In a recent issue of the latter, he tells us that he doesn't like officialdom. "My own suggestion—and I present it freely to the Government without asking for any kind of award—is to abolish part of the existing Civil Service and to establish a new Civil Service manufactured entirely out of plastics. It would be cheaper to make and to maintain, fully as decorative. . . . The plastic official would be moulded (from bakelite or impregnated wood) in the sitting position. He would be practically unbreakable and would be unaffected by temperature. As he could be left in the office over night he would save transport." (Stewart might have added that he would be completely inert and unaffected by outside influences such as acid attack.)

Hope for Corset Makers

My readers may wonder with tinge of suspicion why I resuscitate the problems of replacing corset "bones" or steels with plastics. I am not interested in these objects except in an impersonal way and can look into any window exposing these female appendages without a tremor. Even the famous shop in Regent Street, which shows the men's variety and tells me I should wear one to preserve my figure, affects me but little. But there is a strong medical reason why women should wear them, and it seems to me very foolish that the Government should have cut the steel quota for them. In the September issue I suggested that a way out might be to use less steel by extruding cellulose acetate round a thin steel rod which would give the necessary springiness. It has also been suggested that laminated material should be used, but I should imagine that this would be rather too brittle. This brittleness in thin slivers is a matter that has been concerning the plastics industry for a long time. The brittleness of thin laminations does not affect the electrical industry, which is the main outlet, very much, but if this disadvantage could be overcome I believe the field for the material would immediately be widened. I have long considered that a type of resin, phenolic preferably, could be made dispersed in a solid yet non-brittle compound, to form a bastard thermosetting resin, if I may so call it. Some attempts were made to produce such a resin some years ago, using rubber as the compound in view. We now have on the market a very promising resin made by a British company in which a phenol-formaldehyde resin is combined with a specially treated form of rubber. Presumably this has been chosen since it possesses some fairly reactive groups which ordinary rubber does not have. However, the result is interesting, for the laminated sheets made from it are readily mouldable and are not brittle. A London concern is moulding some interesting shapes from it. News also comes that nylon has been moulded to give extremely strong non-brittle forms. Judging from the brush bristles that are now made, nylon may prove the most suitable plastic. After all, chemically speaking, its composition is closer to whalebone than that of any other synthetic material, and I believe it was Staudinger who once said that the strongest plastic would be a protein-like synthetic.

C

Inquiries and Answers

(In Which is Included General Correspondence)

IMPORTANT NOTICE: If inquirers wish to receive replies by post, a stamped and addressed envelope must be included in their letter. It is understood that the submission of a problem to the Editor permits its publication in this journal

Production of Metal Powders

I am interested in an article which appeared in the July issue of "Plastics" entitled "Plastics and Powder Metallurgy," by H. W. Greenwood, and would particularly like to know what is meant by "percussion methods" as mentioned in the eighth paragraph.

I should like to have the fullest information as to what these methods are, what type of plant is necessary, and the makers of same. R. H. TURNER.

London, W.C.2. (Turner and Newall, Ltd.)

[EDITOR'S NOTE.—We have received the following notes from Mr. Greenwood in answer to this query:—

"In reply to the letter from Turner and Newall, Ltd., Rochdale, the 'percussion methods' mentioned in the eighth paragraph of the article on 'Plastics and Powder Metallurgy,' in the July issue of 'Plastics,' means methods of producing flake-like particles by a succession of blows or by pressure as in stamping and beating. The usual methods of abrasion or grinding tend to produce rounded or spherical particles, whereas percussion methods produce flake-like particles which are essential for certain purposes. The type of plant used comprises generally stamps, that is, steel hammers raised by cam action and allowed to fall on a steel anvil or mortar suitably designed. Generally, a battery of stamps is used and they vary in weight, etc., according to the exact type of flake powder which is to be produced. In some cases special types of ball mill can be used for the same purpose with or without the presence of an inert gas. Plant for this purpose, i.e., the production of flake powders, is not so far as I am aware produced in this country. There are only one or two installations actually at work here and the machinery has all been imported."]

Cutting Perspex Sheet

As you will see from our letter heading, we are principally engaged in the glass business.

The progress in the manufacture of transparent plastics has, however, caused glass to be replaced by this substance for some purposes. We have been experimenting with "Perspex" regarding obtaining circles from sheet of various thicknesses.

As you are no doubt aware, Perspex is manufactured and sent out with a covering of paper to protect the surface, which is very vulnerable to mechanical damage, and it is the preservation of this surface which is our chief difficulty.

We have experimented with a circular cutter, a pair of blanking tools, and also sawing out roughly to shape on band saw and then turning in lathe. The first two processes necessitate the removal of the protecting paper, the first on account of lubrication and the second on account of heating. This means that the surface has to be cleaned afterwards, and this we find impossible to do without causing minute sleeks and scratches, which compares very unfavourably with the original surface.

The sawing and turning method is the only process we have yet tried in which the material can be kept dry and the paper left intact, which, of course, preserves the original surface.

Birmingham. PEARCE AND CUTLER, LTD.

[EDITOR'S NOTE.—It is our conviction that for the production of circular plates from Perspex, blanking tools should not be used if the surface is to be retained. For blanking, the resin would have to be warmed and while in this condition would take not only the slightest impressions in the base on which it rests, but those on the tool itself. It is doubtful even if a billiard cloth protection would do. Sawing, and best of all, the use of a trepanning tool mounted in a boring mill, are really the only satisfactory methods, and are adopted by all factories. In passing, while lubrication with oil or water to carry away the heat during sawing is sometimes employed, if the correct type, rake and speed of saw be chosen very little heat is evolved and no lubrication is necessary. Finally, all workers with this beautiful resin should wear gloves.]

Source of Nylon

We trust that you will excuse the liberty we are taking in writing to you, but we are desirous of obtaining some information which we have not been able to obtain elsewhere.

At the present time we are making some laboratory experiments with plastics, and we should like to obtain a sample of nylon.

If you could kindly furnish us with a source of supply in this country we should esteem it a favour.

THE WALL PAPER MANUFACTURERS, LTD.

[EDITOR'S NOTE.—Nylon is manufactured by Imperial Chemical Industries, Ltd., from whom it is possible to get a sample. Present production is probably all devoted to war work.]

Polyvinyl Chloride Resin

We notice in the September issue of "Plastics," page 175, an article in connection with the use of a plastic known as Mipolam, which has been used extensively in Zeppelin construction, possessing non-inflammable qualities. It is this latter quality in connection with the production of this plastic as a transparency which is of interest to us, and we should be glad if you would kindly put us in touch with any firm in a position to supply this plastic or its equivalent.

It is required in connection with the production of moulded aircraft parts, and we should, therefore, be glad if you could supply this necessary information.

GRAVINER MANUFACTURING CO., LTD.

Fareham.

[EDITOR'S NOTE.—Mipolam is a polyvinyl chloride resin made in Germany; British resins of this type are now being manufactured by I.C.I. (Plastics), Ltd. (under the name of Welvic), and by BX Plastics, Ltd. (under the name of P.V.C.]

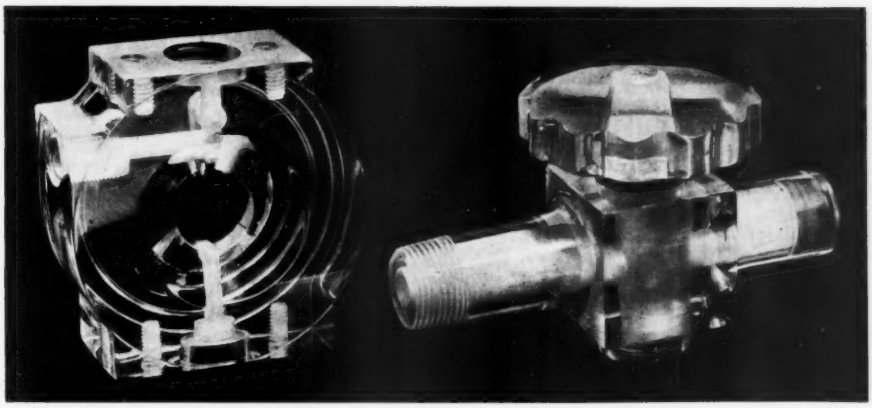


Fig. 1.—Pump-casing and stop-cock machined from Catalin, the transparent cast phenolic resin.

Seeing How It Works

For the first time in history the engineer can now make economically a solid transparent unit for research or, on occasion, for practical operation

THE engineer has always been envious of the chemist, who, by using glass apparatus in the laboratory, can see the course of his experiments. Even the chemist, however, when his experiments become large-scale operations, cannot use glass for his plant, but must employ strong opaque metals or other material.

The demand for transparency by the engineer has never been articulate, for engineering technique has been developed in opacity and has overcome most difficulties. Indeed, it is not yet clear how far transparency will prove useful, for, since it can only be provided by organic plastic materials (glass is too brittle and cannot be manipulated to the same extent) and transparent plastics have certain disadvantages, it is difficult at present to see the full extent to which they will be adopted.

Already before the war transparent thermoplastics, especially of the methyl-methacrylate class, had been adopted for exposition purposes, e.g., the internal working of water beaters, etc. To-day cast phenolic resins are also assuming importance, and, since they are thermosetting and can be machined easily, give promise of much.

Fig. 2 (above).—Water-cooler pump made for Rolls-Royce, Ltd., by J. Burns and Co., Ltd.

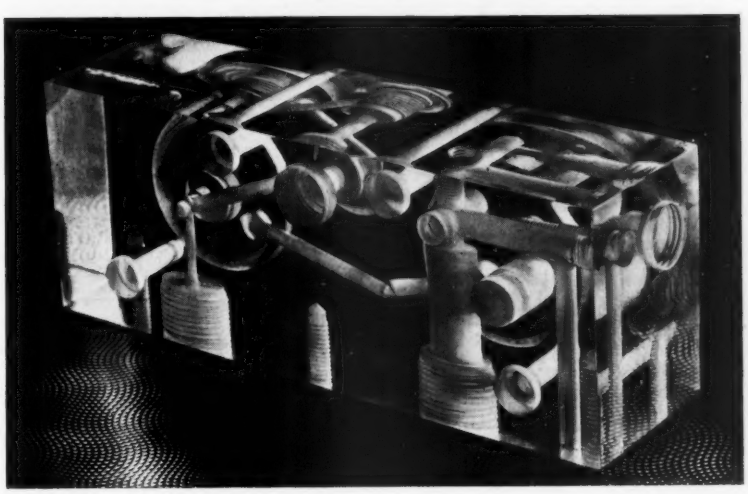


Fig. 3 (below).—An intricately machined unit made from block Catalin. Stated to be a gas distribution unit.

Our photographs show some magnificent examples of what can be done with these hard, tough and yet beautiful substances. For example, machined from Catalin for the famous engineering concern Rolls-Royce by J. Burns and Co., Ltd., Fig. 2 shows an exact copy of a water-cooler pump which has been made so that certain experiments can be observed. Without going into the problem of relative costs of machining the steel object and

(Continued on page 204)

The Boat Wut

The advent of synthetic resin glues and the new technique of "moulding" plywood strengthened with them has opened up new fields in boat-building. The new methods here described are equally applicable to aircraft construction

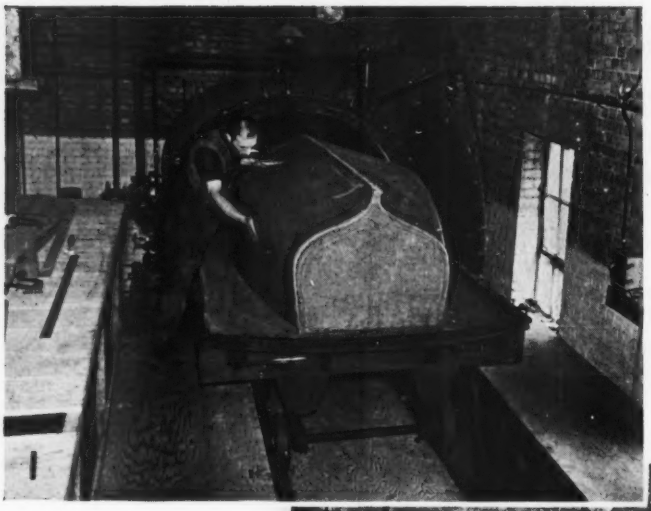
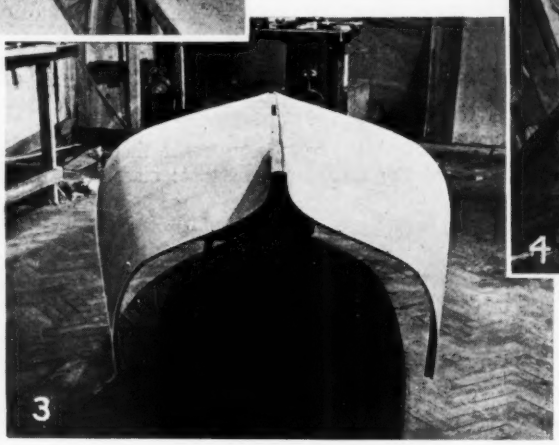


Fig. 1.—The shell, fitted round the "male" mould, ready for curing.

Fig. 2.—Shell and mould are placed in the autoclave.

Fig. 3.—The cured shell removed.



WITHIN the past five or ten years plywood has assumed new significance and has wrenched itself from the rut of " poor relation to wood " to assume a position that may yet prove superior to wood for many purposes, and to enter new spheres where wood as such could never hope to be used.

This modern story of plywood has already been told in part in these pages; it is a story in which synthetic resin plays the major role, for without those resins which form the foundation of our industry, 1941 plywood would have remained just 1930 plywood.

Certainly we are in a new era of glues in which our conceptions of these materials are completely changed. It is no longer that glues should or must form as thin a film as possible between two layers and it is no longer true that the wood veneers are stronger than the glue films. These synthetic glues may be quite thick and they are often stronger than the wood they join. Finally, modern chemistry has produced that most desirable of glue—the cold-setting phenol-formaldehyde resin glue that hardens in 10 mins. or so, and is unattacked by water, acids, fungi and bacteria.

The most sensational developments in the past few years have, of course, taken place in the field of furniture and even more spectacularly in aeronautics, where aircraft flooring, airscrews (those described on p. 190 and made from thick planks of mahogany can be considered as a sublimated plywood) and more latterly complete fuselage structures have been fabricated.

The most recent development we have encountered has been shown to us during a visit to Merron, Ltd., of London, E.3, where new methods of shaping resin-bonded plywood have been adopted. Moreover, as will be seen, we have encountered for the first time the practical development of double curvature, a process we have already indicated as being as rare as it is desirable.

The history of plywood for the production of small boats is by no means new. The first were made about 35 years ago, using ordinary animal glue as the adhesive between the veneers, but unfortunately after a few weeks' service these came apart. This was followed by a change of glue—the adoption of casein, which resulted in boats with a life of one or two years where they were in continual service, or longer in the case of dry storage

Wut a Nail

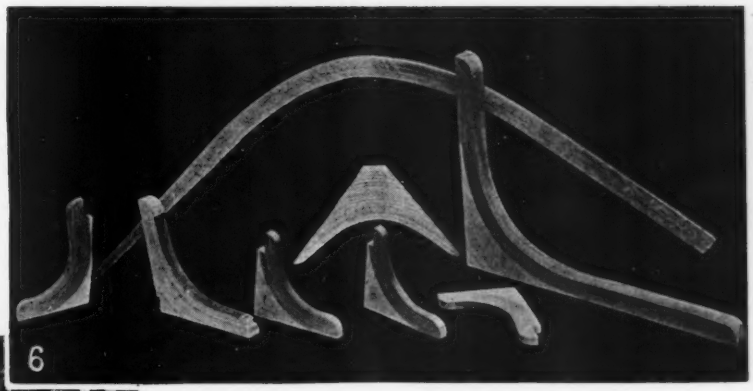


Fig. 6. — Laminated knees, breasthook, apron and stem.

Fig. 5. — Fitting the outside stem.

Fig. 4.—The transom assembly and thwarts are dropped into place.

when not in service. This short life demonstrated that although casein glue was far more water resistant than animal glue it could not be said to make plywood structure completely waterproof.

The synthetic resin glues of the phenol- and urea-formaldehyde type for plywood are well established in boat-building to hard-chine design where the curvatures are single; many such small craft have been built in America. Obvious difficulties arise when the compound curves of round-bilge boats are desired. This has been done successfully in this country by the patented process of Merron, Ltd., London. The methods adopted resemble in some degree the reported processes employed for the manufacture of the so-called plastic aeroplane in the U.S.A.

The method of manufacture is, in general principle, as follows.

A mould of the desired form is constructed in wood or metal and suitably perforated to facilitate the production of an internal vacuum. Slots are cut in the mould to receive any internal bracings which may be required in the ultimate structure—in the case of a boat the keel/hog/stem assembly and the gunwale.

Mahogany veneers are formed into phenol-bonded sheets in a manner which gives them a fabric-like multi-directional pliability and packs of such sheets are then cut into a pattern obtained from a development of the mould surface, in a method not unlike those used in mass-production tailoring.

The interior bracings having been laid in their appropriate slots, the patterned sheets are placed on the mould, coated with a special phenol-formaldehyde resin and the desired thickness built up.

When this shell structure is complete the whole is covered with a rubber counter-mould and the complete assembly, which has been made on a trolley running on a rail track, is moved into a large, steam-heated autoclave.

The pressure vessel is closed, vacuum is applied from within the mould, while external pressure (about 50 lb. per sq. in.) is exerted on the face of the assembly, the temperature being maintained at about 80 degrees C.

After a period of about 10 mins. curing is complete and the now completely formed shell is removed.

The boat is finished by fitting on the outside stem, transom and interior thwarts and knees, many of which sections are themselves of phenol-bonded laminated construction.

These 10-ft. dinghies, which weigh about 80 lb. apiece, have a skin thickness of but $\frac{1}{4}$ in., but no internal ribs or stringers. The absence of internal framework is, of course, a great point as regards cleanliness, freedom from rot-generating crevices and ease of maintenance, while from the appearance point of view the smooth, jointless surface and the beauty of the wood veneers put them far in advance of even expensively constructed conventional craft. They are, of course, tremendously strong, cannot leak and, in spite of their low weight, the absence of nails gives them a high reserve-buoyancy figure and they are thus particularly useful as life-saving craft.

We presume that the strength of these structures—especially of the glue film itself and the fact that nails are unnecessary to bond shell and keel, will surprise the pundits.

Other advantages claimed for craft constructed in this way are that there is absolute identity between hulls, which not only facilitates the construction of interior fittings but would mean that a one-design class of racing craft constructed by Merron process would be a really one-design class. Additionally, the designer's requirements can be more faithfully interpreted than by conventional building, and, in fact, as laminated wood is

(Continued on page 204)

World's Industrial

GENERAL ENGINEERING

Working and fitting tubes of polyvinylchloride are described in a communication from the Verkaufsgesellschaft für Kunststoff — Erzeugisse m.b.H. The tubes are best cut with hack saws or bow saws; hand or circular saws may be used, but care should be taken to avoid overheating as the resin will soften and tend to clog the blade. Tubes may be jointed in a variety of ways. Thus the straight plug-in joint involves the bevelling of the end of one tube with a file or stone, the end of the other half of the joint being heated up to 130 degrees C. in hot oil or hot air and drifted, care being taken to avoid any overheating, local or otherwise. When it has been sufficiently expanded, the other tube is inserted, the bevelled end being brought up hard against the shoulder of the expanded part. Alternatively, the adhesive PC.20 may be used to ensure a tight fit. Flanged fittings to permit of tubes being bolted together may be fixed in position with adhesives, or screwed unions may be used. Bends and Ts and expansion pieces are available from the tube suppliers. Supports should be provided at intervals of 0.7-1.5 metres, care being taken to see that free motion is possible between runs and the expansion piece; under no circumstances should the supports clamp the resin tubing too tightly. **Mechanical Testing of Cellulose Acetate** was the subject of a paper by W. N. Findley at the 44th annual meeting of the American Society for Testing Materials. Tests carried out consisted of short-time tensile tests using an extensometer, long-time constant load (time-to-fracture) tensile tests, and vibratory bending fatigue tests of notched and unnotched specimens. The author found that the upper yield point, the lower yield point and the fracture stress all increased with increasing speed of testing until a critical speed was reached at about 1.5-2 in./min., beyond which these values remained substantially constant. An examination of these data indicated that the values of the lower yield point were more consistent, as shown by less " scatter " in the results, than either the upper yield point or the fracture stress. Incidentally, the lower yield point was readily determined, at any testing machine speed, with any machine on which the load was self-indicating. In the endurance tests it had been found that with cellulose acetate, as with other materials, the shape of the specimen seemed to have a distinct effect upon the endurance limit under repeated stresses. **Ameripol,** the synthetic rubber produced by Goodrich Co., Akron, Ohio, is specially adapted in fabric-coated form for diaphragm service in gas meters or in fuel pumps. Thicknesses normally used are 0.005-0.05 in. **Refrigerators** in 1942 will have more than 50 plastic parts, is the prediction of the Plastics Dept., E. I. du Pont de Nemours. In all, there are at least 77 possible applications. Presumably expansion of plastics in this field will be hastened by the world scarcity of metals.

CHEMICAL

Water purification by means of specially adopted synthetic resins which function as base - exchange media was discussed by Griessbach in an appendix to a past issue of " Z. Verein D. Chemiker." The discovery of this property was first made in England and embraced initially certain phenolics and amino plastics. More recently, the capacity for, and velocity of exchange for various anions and cations has been increased by developmental work undertaken by I.G. Farbenindustrie, which concern has, in addition, further increased the range of condensation production to include those possessing the property of adsorbing certain less reactive cations and anions which, hitherto, could not be removed. Richter in " Kunststoffe " and Mienes in " Kunststoff Technik und K. Anwendung " present detailed discussions on various aspects of the problems involved, and upon the available resins suitable for various purposes. Even colloids may, under appropriate conditions, be treated for the removal of foreign anions or cations, without causing breakdown of the suspension. For the removal of metallic salts amino resins have been shown to be suitable, the adsorbing medium being regenerated and freed from the metal by treatment with acid or water. Particularly in the purification of foodstuffs, such as wine, from traces of lead, copper or arsenic, the new reagents do not replace the heavy metal removed by an equivalent of alkali as in the case of zeolites. Hormones, vitamins and ferments may be treated for the removal of inorganic salts without in any way affecting the properties of the main product.

RAILWAYS

Impregnating media for fabric roof coverings for railway trucks on the German State railways are based on Oppanol mixtures of a pasty consistency, according to Metzkow in a dissertation before the Deutsche Maschinetechnische Gesellschaft. Employed under the name of " Tromipaste " such mixtures are claimed to be definitely superior to boiled-oil compositions, and, unlike the latter, need no extra protective coatings of paint. In this connection it will be recalled that for some year of so now tarpaulins treated with Mipolam have been recommended for uses similar to that suggested here. A point of some current interest is the fact that Mipolam-treated tarpaulins are stated to be highly resistant to the so-called mustard gas.

ELECTRICAL

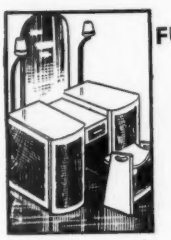
Electrical and mechanical properties of synthetics for structures for electrical engineering purposes are summarized and discussed by Burmeister in a past issue of " Kunststoff-Technik und K. Anwendung." For heavy duty, mouldings must be sufficiently heat-resistant safely to withstand all normal overloading in service; moisture-absorptive capacity should be low and of a determinable value; tracking should be at a minimum even under unfavourable circumstances, as, for instance, when the surface of the component becomes contaminated with dust and moisture. Resistance to change by light, oil and ozone are also important in numerous cases, the requirements of which must be adequately ascertained before selecting a material for use. **Electrical screens** on a plastic basis appear to offer great promise both for present and post-war use. Produced by spraying metallic films on to cast or moulded resin bases, cases and covers, light in weight, more rigid than sheet metal assemblies and, at the same time, possessing all the properties of metallic articles in so far as electrical conductivity is concerned, may be manufactured at highly economical

mploys Plastics

rates. This development, which is to be described in more detail in a forthcoming issue of "Plastics," would appear to present opportunities for economizing in metal and for evolving new and more compact designs for portable and transportable electrical plant and instruments, as the spraying process enables continuous complex screens to be produced on a finished job and facilitates the elimination of the multiplicity of individual screening covers.

TEXTILES

Printing of fabric with a solution of vinyl aceto-formal resin is the subject of a patent, U.S. 2,245,123, issued to the Societé Nobel Française. **Sizing of cellulose fabrics** with methyl methacrylate resins is suggested by E. I. du Pont de Nemours in a recent patent. **Lettering and engraving technique** for plastics are discussed by Paasch in a past issue of "Kunststoff-Technik und Kunststoff-Anwendung." It is pointed out that the usual method is to imprint direct from a suitably engraved die during moulding, the lettering being afterwards filled in with colour if necessary. Less permanent are transferred impressions, lacquer coated to improve resistance to wear by handling. A German concern has recently brought out a modified hand press with which, it is claimed, descriptive matter can be printed on to plastics from ordinary type via a ribbon treated with a suitably coloured adhesive "ink." The apparatus is so operated that plane or curved surfaces can be handled, the resulting print being afterwards given a coat of protective lacquer. Special colours, including gold and silver, have been developed for use with the machine, which is ideal for handling plastic packs and packing materials on a production basis. **Sap of eupherbia resinifera,** or milkweed plant, overgrowing an area of some 40,000 acres in North Africa, is being experimented upon in France in the hopes of obtaining from it a rubber substitute. Health hazards, however, appear to be associated with its utilization; it may cause blindness in operatives. A Government laboratory in Casablanca appears to have evolved a simple production method. The yield is estimated at 30 tons per acre, a figure which appears definitely of economic interest.



FURNITURE

Bolts and catches for furniture are referred to in a past issue of "Eisenhändler." The new fittings, which are of the non-flush type, are in reinforced-resin mouldings and are provided with strengthening bosses of brass at the screwholes. **Fancy goods and fittings** in a plastic mass referred to by the trade name "Seelet" are noted in a past issue of "Kunststoff-Technik und K. Anwendung." The new plastic is in the form of a soft putty-like mass which is kneaded into shape and then submitted to a special drying process. It is said to be extremely cheap and very economical and to offer the possibility of using plastics even where the usual types are too expensive. **Office equipment** has long formed an ideal field of exploitation for synthetic resins. This and other spheres of application is discussed in general terms by Pabst in a past issue of "Kunststoff-Technik und K. Anwendung." The author stresses the fact that the electrical properties of plastics have commended these materials for a wide range of electrically operated apparatus, but he differentiates this field from that of purely constructional use, for which latter purpose the resin employed must be selected carefully according to the service it must perform; he discusses the intricate problem of selecting suitable plastics for the manufacture of typewriters and adding machines.

MISCELLANEOUS

Imports of bakelite and casein compounds into Philippine Islands have increased to 85,000 lb. in 1940 from 14,000 lb. in 1939. Japan, U.S.A. and Argentine are chief suppliers, followed by Netherlands, E. Indies, Australia, Canada and Gt. Britain. **Ministry of Aircraft Production** has issued Spec. D.T.279 A, for pigmented lanolin-resin solutions. This is to be employed for certain road-making compositions. Proportions of the ingredients, e.g., lanolins, resins, pigment, clay and white spirit, are included in the spec. **Methyl alcohol** and thence formaldehyde is now being produced by a new wood distillation plant at Quellon, Chile. **Fire-retarding Synthetic Resin** paint is the subject of a recent article in the News Edition Ind. Eng. Chem. The ethylidene urea resins are discussed. Good results were obtained with phosphoric acid mixtures with the latter resin. **Shellac** as a moulding resin forms the subject matter of a past issue of "Kunststoffe." The author points out that shellac may be polymerized beyond the state in which it occurs naturally, but that the operation cannot be done under pressure as water is present and causes the polymerization process to reverse. The curing temperature is, for the untreated material, 190 degrees C., but both this and the curing time may be reduced by additions of accelerators. Urea additions have been found very satisfactory. Mechanical and electrical properties can be improved by extracting from the crude shellac certain more soluble constituents. **Temperature indicating compounds** for the safeguarding of relatively low-temperature apparatus or for determining the attainment of given low temperatures are tabulated in an account in a past issue of "D. Apoth. Z." The range of temperatures covered is of interest to the plastics industry and is, therefore, recapitulated here together with the appropriate compound. $NiNH_4PO_4.6H_2O$ changes from bright green to grey-green at 120 degrees C.; nickel-pyridine thiocyanate changes from blue to bright green at 135 degrees C., and from bright green to yellow at 210 degrees C., undergoing a third change to brown at 340 degrees C.; copper - pyridine thiocyanate changes from green to yellow at 135 degrees C. and from yellow to black at 220 degrees C.; $CoNH_4PO_4H_2O$ changes from purple red to deep blue at 140 degrees C. $[Cr(urea)_6]Cr)CN)_6$ changes from green to brown at 140 degrees C.; $(NH_4)_3\ PO_4\text{-}12MoO_3$ changes from yellow to black at 140-degrees C.: $(NH_4)_3PO_4\text{-}12MoO_3$ changes from yellow to violet at 140-150 degrees C., from violet to bright blue at 220-230 degrees C., and to brown at 280 degrees C.; NH_3VO_3 changes from white to brown at 150 degrees C.; and turns brown-to-black at 170 degrees C.; $(NH_4)_4H_6[Ni(MoO_4)_6]$ .5 H_2S changes from whitish to grey at 180-210 degrees C.; $[Co(NH_3)_5Cl]Cl_2$ changes from purple to dark blue at 190 degrees C.; $(NH_4)_2U_2O_7$ changes from yellow to grey at 200 degrees C.; $[Co(NH_3)_6]PO_4$ changes from yellow to blue at 200 degrees C.; $[Co(NH_3)_5Cl]SiF_6$ changes from purple to grey at 200 degrees C.; $[Co(NH_3)_6]_2(C_2O_4)_3$ changes from yellow to violet at 210-220, violet to brown at 250-270, and brown to black at 320-350 degrees C.

PRODUCTION NEWS

Raw Materials, New Plant, Works Organization, Control Apparatus, Research, Personal and Trade Notes

INSURANCE OF MOULDS.—The following resolution has been prepared by the moulder members of the British Plastics Federation, Ltd., and approved by the Board of Trade as a basis for the insurance of moulds under the War Damage Act, 1941:—

"That all the moulder members of the Federation shall remind their customers of the fact that they hold moulds for which part cost has been paid, and point out that such moulds have to be insured under the War Damage Act, 1941.

"Only those moulds which are in use for current production or have been in use since August 31, 1938, will be insured by the moulder holding the moulds.

"All others will be regarded as obsolete unless the customer can show reason to the contrary.

"Moulds in the possession of, or held at the disposal of, a Government Department are not insurable under the Act."

RETAIL TRADE COMMITTEE.—The President of the Board of Trade has appointed Mr. Lawrence Neal as a member of the Retail Trade Committee set up to advise the Board on the problems of the retail trade.

On account of the pressure of work entailed by his appointment as Director-General of Civilian Clothing, Mr. Metford Watkins has resigned his membership of the Committee.

Mr. Neal is the chairman and managing director of Daniel Neal and Sons, Ltd. He is also vice-chairman of the Joint Industrial Council (and chairman of the Employers' side) for the Retail Drapery, Outfitting and Footwear Trades.

RUBBER PUBLICITY. — The British Rubber Publicity Association (Temporary address: 1, Albert Mansions, Lansdowne Road, Croydon) has issued the following publications which are of interest to a wide circle of readers. There is no charge for this literature:—

Pneumatic Tyres and other Products on the Farm; Some Applications of Rubber in Horticulture; Modern Equipment for the Poultry Farm; Uses and Possibilities of Rubber in Agriculture; Field Transport of Cane on Steel and Rubber; Rubber Tyred Farm Tractors; Rubber Equipment in Modern Farm Management; The Bullock Cart or the Tjikar as a Road Destroyer; Use of Rubber and Rubber Plastics for Byre Flooring; Rubber Tyred Farm Vehicles; Uses of Rubber in Greenkeeping; Report of Pneumatic Tyred Carts and other Equipment Tested at Reading University; Rubber in Automobiles; Rubber in Paints and Varnishes; Rubber Latex; Rubber in the Mining Industry; The Use of Rubber in Furniture; Rubber and its Applications; Handbook on Rubber (issued at the Empire Exhibition, Glasgow); Endless Rubber Belts; Rubber and Latex in Furnishing and Decoration; New Uses for Rubber; Rubber in Chemical Engineering; The Care and Treatment of Rubber Flooring; Recent Developments of Rubber in Industry; Rubber and Railways; Rubber and its Applications in the Building Industry; The Electrical Properties of "Rubbone"; Abstracts of Patents Relating to "Rubber Latex"; How Rubber Helps During Air Raids; Rubber and its Engineering Uses.

ROT PROOFING OF SANDBAGS.—A most important subject in all factories in these days is the problem of adequate rot proofing of sandbags, and indeed of wooden structures. In the September 13 issue of "Chemistry and Industry," Dr. E. F. Armstrong, the chairman of the Sandbag Advisory Committee to the Ministry of Home Security, describes the importance of treating jute and other fabric bags with the various chemicals that have now become standard: creosote, copper and zinc naphthenate in solution or emulsion, cuprammonium, etc. The first two named are extremely effective although creosote, in view of its colour and odour, is not always desirable. Copper naphthenate is extremely valuable, while the cuprammonium process has much to recommend it but it is not so effective as the preceding ones. Dr. Armstrong criticizes strongly the filling of unproofed bags and shows that whereas the proofed bag can have a life of two years or more, the unproofed bag decays in anything from 21 days upwards, with an upper limit of about 90 days. The filling of bags with earth or concrete is dangerous.

RESIN-PAPER BOARDS. — The latest of a series of E.R.A. reports on the fundamental properties of dielectrics deals with the "Dielectric Properties of Experimental Resin-Paper Boards" (Ref. L/T100). In this, Dr. L. Hartshorn, Messrs. E. Rushton (National Physical Laboratory) and N. J. L. Megson (Chemical Research Laboratory) describe experiments made on laminated boards prepared from the pure phenolic resins which have already been investigated and on a representative sample of paper.

NEW B.S.S. (Bonded Fabric Sheet).—The only British Standard Specification covering synthetic-resin bonded fabric sheet has been B.S. 668, which covers materials for use in the manufacture of gears. A new specification has now been issued to provide for types of synthetic-resin bonded fabric sheet having properties which make these types of material suitable for electrical purposes. These types may also be more suitable than the gear material.

This new specification ("Synthetic-Resin Bonded Fabric Sheet for Electrical and Mechanical Purposes," B.S. 972) covers three types of bonded fabric sheet of thickness between 1/64 in. and 4 ins. The specification is divided into three parts, the first part containing general clauses, Part 2, containing mandatory clauses to be applied to all material, whether for electrical or mechanical purposes, and Part 3 optional clauses which are to be applied when the purchaser specifically indicates that the material is for electrical purposes.

Copies may be obtained from the British Standards Institution, 28, Victoria Street, London, S.W.1, price 2s. 3d. post free.

PERSONAL NOTES

R. E. Layzell, F.L.A.A., has been appointed accountant to the Plastics Department of Thos. de la Rue and Co., Ltd. He thus severs his connection with television, having been secretary and chief accountant to Baird Television—the latter office since 1928, with promotion to secretaryship in 1932.

At a recent board meeting of Kayser, Ellison and Co., Ltd., the following appointments were made:—**Captain Leonard A. K. Halcomb** to be deputy chairman; **Mr. Percy B. Henshaw** and **Capt. L. A. K. Halcomb** to be joint managing directors, along with the chairman, Mr. Charles Wm. Kayser.

SPEED NUTS. — We have received notification from Simmonds Aerocessories, Ltd., that the range of nuts and fastenings hitherto sold by them under the title of Speed Nuts will henceforth be known as Spear Nuts.

Resinoids and Other Plastics as Film Formers

By B. J. BRAJNIKOFF, Consulting Electrical Engineer

One-time Consulting Engineer to the International General Electric Co., Inc., New York

II.—Plastics Synthesis in Relation to Raw Material Base

ONE of the basic problems of the coating field is the synthesis of chemically pure film-forming substances of individual types, in contradistinction to the use of a mixture of bodies, often of indefinite constitution and structure that are not able to ensure the standard quality of products.

The answer to this problem, evidently, cannot be sought in the mere substitution for natural ingredients of certain synthetic structures analogous to classical component materials in coating media (e.g., the drying oils in varnish systems, etc.), as their scope of utility is restricted by inherent physical and chemical features, limitations of supply and other technical and economic factors.

For example, the requirements which the coating compositions have to meet in application to the rubber industry cannot be satisfied by the deposition of protective films based on the linseed and China or tung oils, since the latter are deleterious due to transfer of oxygen by the oxidizable film to rubber, which stimulates its ageing. The rubber articles need specific coatings, obviously of the polymerization type, possessing high elasticity, stability to temperature changes (especially to frost) and other physico-chemical features.

Another point to be borne in mind here is the imperative requirement of the compatibility of a resinoid with the vehicle used, such as drying oils, aqueous or other media; for instance, a poor solubility of the phenol-aldehyde resins in linseed oil greatly retarded their application in oleo-resinous compounds.

Hence in order to render phenolics soluble in oils they must be modified by an appropriate treatment, which is generally accomplished either by (1) the preparation of the so-called "straight" oil-soluble phenolics by using phenols containing substituent groups of minimum three carbon atoms at the para position to the hydroxyl group, and (2) the formation of hybrid products, i.e., the cross-polymerization, by fluxing the phenolics with natural resins, so as to build complexes that are freely miscible with the drying oils.

The radical solution to the problem could be realized only through direct chemical syntheses of coating compositions on the basis of reactions yielding products of chemical purity, which are capable of producing films with well-defined characteristic properties and predictable behaviour.

Trend of Modern Research

The researches on the synthesis of film-forming agents may be divided into two groups. The first is confined to the production of synthetic film-forming substances, chiefly based on natural raw materials, including the "semi-drying" and "non-drying" types of oils and fats of vegetable and animal origin, such as castor oil, olive oil, fish oils, etc.

With the aid of special treatment the research worker endeavours to render them suitable substitutes for the drying oils of the linseed group (in the form of boiled oils), which until recently were by far the most important basic vehicles in paint and varnish systems.

The preferential use of the oils of the linseed group in coating compositions depends upon the properties of the films obtained on the drying of these oils. The feature of the coating produced by the linseed oils is connected with the presence of a sufficient amount of the linoleic acid, or its isomers, and with the structure of mixed triglycerides.

Good or bad quality of boiled oil is determined by: (a) the duration of its drying period under usual conditions, which for technical reasons should be within definite limits, and (b) the properties of the films produced. The distinct characteristics of coatings derived from the linseed oil group are their almost complete insolubility in organic solvents (in normal conditions of maturing), the absence of synæresis, and infusibility. Owing to these properties the films of the linseed oil, free from impurities, resemble infusible plastic products. In this connection a number of investigators regard the matter of such films as consisting of the two- or three-dimensional structures.

Conversion of Semi-drying to Drying Oils

As a means of converting the semi-drying and non-drying oils into the drying type of products, they are subjected to various processes. The metamorphosis of non-drying oils into the drying oils is best exemplified by the remarkable work of Scheiber, who succeeded in transforming castor oil into the drying variety by the dehydration of the ricinoleic acid, i.e., by the total reconstruction of the original molecule.

Concurrently with the above, efforts are devoted to the study of the chemical and physical processes occurring during their treatment, with the view to improving the quality of the drying oils.

In this field the investigations of Eibner and his school have been particularly fruitful. By the separation from drying oils of constituents suitable and unsuitable for the preparation of high-quality films Eibner has obtained the so-called "Stand oil extract," and found the method which not only improves the properties of coatings, but also opens the way for utilizing non-drying oils.

The re-esterification of glycerides is also employed by means of introducing fatty acids of one type or another into a molecule of glyceride. As a result of the radical chemical treatment of semi- and non-drying oils, i.e., the transformation of acids having a low degree of

unsaturation, of the type of the oleic and ricinoleic acids, into acids with a higher degree of unsaturation, new film-forming agents have been found which are in no way inferior to the natural linseed oil.

Dealing with complex mixtures of materials of unknown composition and structure, investigators are often interested in merely external and apparent features of a final product, and usually pay little attention to the study of chemical processes. The comprehensive and detailed examination of the chemical reactions that take place is, of course, considerably handicapped, due to the fact that in operations of this nature one has to deal with complexes the chemical purification of which entails many difficulties.

This group of research, the practical importance of which is obvious at the present time, cannot, however, assure either a thorough solution of the coating problem, or the erection of the necessary scientific base for its solution, since the theoretical aspects of the mechanism of film formation must be studied on the basis of individual compounds of definite constitution.

The second group of workers in the coating field attempts to realize the synthesis of film-farming materials based on chemical compositions of specified structure, aiming to discover the relationships and bonds between the units of an organic molecule and its capacity for polymerization and film-formation. Yet, notwithstanding the decisive significance of such investigations in regard to prospects of successfully solving the problem of film synthesis, the results are extremely meagre and are confined to a few single although important examples (e.g., chlorvinyl, acrylates and vinyl esters).

The concentration of attention in research on film-formers, based mainly on the natural oils, clearly shows that the entire problem of the coating media is only at the beginning of its development. The limited range of properties of even the best drying oils and especially their substitutes, should be expanded and supplemented by the derivation of new products, with novel, technically valuable characteristics, which can be accomplished by means of a well-tried process of organic synthesis of such compounds, from which the desired features may be expected on theoretical grounds.

The Lessons of History

In this respect the history of synthesis of dyestuffs is highly instructive. How would this powerful branch of chemical industry look to-day, had it not been for the enormous amount of scientific effort that has been expended in the past by bold pioneers, such as Perkin and his followers, on synthesizing new dyes and determining their structure, or if investigators had confined their attention to synthesis of the natural colouring matters only? Even such a well-known technically standard product as rubber could be derived from dienes of different constitutions, including oxygen-containing compounds. Therefore, the prospects of restricting the research work to some single type of combinations appears to be fundamentally wrong. Whereas in the synthesis of rubber, for example, the question is reduced, essentially, to the working out of the methods for preparing of divinyl, isoprene, and their immediate homologues, in synthesizing the film-forming substances, at the present stage of our knowledge, it is impossible to determine, with sufficient certainty, what molecule and of what constitution should be obtained in attacking the problem.

Under these conditions, it looks as though purely empirical means is to be the only way out. Having regard to the danger of circumscribing the chemical work within a sphere of casual experiments, such a state of affairs in research cannot last long without the most injurious results to the scheme.

Thus, in the interests of creating a firm scientific foundation for tackling the foregoing problem, it seems to be the first pre-requisite is a comprehensive and systematic study of chemical transformations, particularly of polymerization, and the film-forming properties of the various unsaturated organic combinations.

Since the diversity of modern requirements precludes the production of a "universal" film, the solution of the problem will have to be inevitably of a differential type. This immediately brings forward the other fundamental aspect of plastics synthesis in general and of the coating field in particular—the problem of the raw material case.

SOURCES OF RAW MATERIALS

Role of Compounds of the Aliphatic Series

The past 10 years are characterized by an immense expansion in all industrial countries of the output of the organic chemical products of the aliphatic series, which has considerably outstripped the manufacture of the aromatic series.

Such a growth of production of commodities of aliphatic series is due not only to the military significance which this branch of industry has in modern defence (the syntheses of explosives, war gases, the manufacture of synthetic substitutes of the vitally important strategic materials, viz., artificial rubber, wool, leather, etc.), but also owing to that exclusive role, which it has won in satisfying the most diversified needs of peace-time economy.

On the one hand, ethylene, acetylene, carbon monoxide, etc., may be used as the basic starting materials for obtaining the most important products for military purposes; on the other hand, the very same substances as serve as a source for producing innumerable derivatives that provide the base for the manufacture of plastics, synthetic rubber, resins, artificial fibres, solvents, plasticizers, without which the rapid development of many new industries would be impossible.

For example, in the modern progress of industry of solvents, apart from the reduction of manufacturing costs, new synthetic methods of producing solvents opened up the possibility for obtaining higher quality products (e.g., synthetic methanol as compared with wood naphtha, formaldehyde, dichlorethane, trichlorethane, etc.), as well as such commodities which until recently were regarded merely as curious results of laboratory experiments.

These products comprise many secondary and tertiary alcohols obtained as a result of the treatment of petroleum, some alcohol ethers, anhydrous ethyl alcohol, etc. The chemistry of the aliphatic series has reached the greatest development in the U.S.A., where the raw material base has proved to be the most favourable for its formidable expansion, each succeeding year registering the attainment of a new peak level of output far surpassing the preceding year. The most important factor of the rapid growth of manufactures of aliphatic compounds in the U.S.A. is the utilization of methods of organic synthesis for a complex chemical treatment of gases of the pyrolysis and cracking of petroleum and of the natural methane-containing gases.

The unsaturated hydrocarbons of gases of the petroleum cracking provide a rich source of raw materials for the production of synthetic ethyl alcohol and other monohydric alcohols, glycols, and their

various simple and compound esters, acetone and its homologues, acetic acid and acetic anhydride, ethyl chloride (used in synthesis of ethylcellulose and other combinations), iso-octane and polymerbenzene, and, finally, for an endless range of high-molecular solid polymers having character of resins and fibres.

A suitable treatment of gaseous hydrocarbons laid down a solid base in the U.S.A. for great enterprises producing, in addition to high-quality motor fuel, tens of thousands of tons of alcohols: methyl, ethyl, isopropyl and amyl, ethyleneglycol and glycol esters, synthetic resins, solvents, and kindred products.

The Petroleum Refinery as a Source of Plastics

In the U.S.A. it is considered as a well-established fact that at the present time a petroleum refinery is destined to become the producer of organic commodities, and not to remain solely as a source of gasolene and lubricants. It is around such oil refineries in America that the industry of aliphatic compounds is mainly centred, employing ethylene, propylene and acetylene obtained from cracking gases, as a raw material base.

The volume of cracking gases produced in the U.S.A. already by 1937 amounted to 9,905 million cubic metres, or approximately 13 million tons. Since all this colossal quantity of gas cannot be suitably utilized at the point of production, it gave rise to the widely practised liquefication of gases and the marketing of individual gaseous fractions in liquefied form.

About half of all saleable liquefied gases are used as the raw materials for the chemical industry. The liquefied petroleum gases brought to chemical factories are usually subjected to a further cracking and subsequent treatment for obtaining ethyleneglycol, alcohols, acetone and other derivatives. Some of the technological processes are based on the chlorination of pentane for obtaining amylchlorides, afterwards transformed into other products.

The Impact of Agriculture

Side by side with raw materials derived from hydrocarbon gases, the industry of the organic synthesis in the U.S.A. uses also the agricultural products. Thus, in 1937, only 17 per cent. of ethyl alcohol has been produced by synthesis through diethylsulphate, whereas 83 per cent. of ethyl alochol has been obtained by biochemical means. Besides cracking gases, acetone and ethyl alcohol are also manufactured by the fermentation method, and the construction of new works for the production of alcohols and solvents from agricultural materials shows no signs of abating.

Nevertheless, notwithstanding the great importance of cereal base in the production of many organic commodities, the characteristic trend in the development of the organic industry in the U.S.A. is the utilization of the natural and technical hydrocarbon gases and the application of synthetic methods in the organic manufactures. Thus, for example, in 1939, 90 per cent. of methanol (about 103,000 tons) was produced by synthesis and the balance of merely 10 per cent. by means of dry distillation of wood, and of the total output of acetic acid, of about 100,000 tons, only 23 per cent. (or about 23,000 tons) has been obtained from the thermal decomposition of wood. At present the synthetic acetic acid is obtained in the U.S.A. by many different methods, namely, from acetylene, ethyl alcohol and from ketene, derived from propylene through acetone.

Quite naturally, the creation in the U.S.A. of this powerful industry of organic synthesis has given strong impulse to the corresponding development of the consuming branches of industry. The leading role in this respect belongs to the plastics industry, which is the largest consumer of organic products.

The modern manufacture of plastics, with their multitudinous assortment, demands, side by side with phenols, various synthetic products, viz., aldehydes, polyhydric alcohols, acetone, acetic acid, chlorvinyl, vinyl acetate, cellulose esters, esters of acrylic and methacrylic acids, different amides, etc. Numerous solvents employed at the present time are usually synthetic products of the aliphatic series.

Although the great bulk of plastic goods in the U.S.A., namely, from 82 to 87 per cent., have continued to comprise the plastics based on phenol and the phthalic anhydride, i.e., products of the aromatic series, in actual practice, however, the weight of chemical products of the fatty series in the plastics industry is appreciably greater, with the unmistakable evidence of their growing importance in the future of the entire plastics field.

Comparative Growth of " Aromatic " and " Aliphatic " Plastics

This marked upward curve of the commodities of the aliphatic series is due to the fact that, apart from the production of numerous plastics wholly depending on the aliphatic base (e.g., urea-formaldehyde, vinylite resins, acetylcellulose compositions, etc.), the compounds of the fatty series in many instances form indispensable components in the preparation of plastics from aromatic compounds. For example, in the manufacture of the phenolic condensation products each ton of phenol used requires an addition of about 1.5 ton 40 per cent. formalin. Of 20,000 tons of phenol produced synthetically already in 1936, three-quarters have been employed for the manufacture of plastics; hence 15,000 tons of phenol necessitated a simultaneous incorporation of 22,500 tons of formalin, containing 40 per cent., or 9,000 tons of formaldehyde, for the preparation of which, in its turn, were needed 11,000 to 12,000 tons of methanol.

The New Cellulosic Materials

But if in the production of phenolics and alkyds the organic products of the aliphatic series are indispensable merely as ingredients for combining with the basic constituents of the aromatic class, in a number of the latest types of plastics the compounds of the aliphatic series proved to be of decisive importance. They comprise acetyl- and ethylcellulose and amino-plastics, as well as vinyl and acryl resins. The manufacture of acetylcellulose plastics, employed for making non-inflammable films, unbreakable glass, etc., and requiring great quantities of acetic acid and acetic anhydride, as well as ketene for acetylation of cellulose, has increased nearly ninefold in the course of seven years in the U.S.A., that is from 1933, when production began. The 1939 output of acetylcellulose plastics of about 9,500 tons, as against just over 1,000 tons in 1933, whereas the nitro-cellulose plastics for the same period formed around 7,500 and 5,000 tons respectively.

The last three years brought a new type of cellulose plastics—ethylcellulose products—which in all probability will find a very extensive application, often in the very same fields as the acetylcellulose. The great quantities of ethyl chloride which are required for the production of ethylcellulose plastics is again ensured in

the U.S.A. by the well-developed chlorine industry, based on cheap electric power and ethylene released from cracking gases.

The plastics derived from compounds of the aliphatic series, the next in importance after the cellulose products, are the urea-formaldehyde plastics, the manufacture of which, begun in the U.S.A. in 1933 with the output of 1,470 tons, by 1939 already rose up to nearly 7,000 tons.

It is of interest to note that the production in the U.S.A. in 1933 of all synthetic resins of the aliphatic series, including amino-resins (1,470 tons), barely reached 1,515 tons; by 1936 the output of these resins had already passed beyond 7,000 tons, i.e., was greater than 4.6 times. This growth was due, in the main, to the progress in the synthesis of novel types of resinoids, namely, vinyl resins, the derivations of vinyl chloride and vinylacetate (in their turn obtained synthetically from ethylene or acetylene), as well as alphamethacrylates (usually from acetylene).

The Growth of Vinyl and Acrylic Resins

There is no published record of output of vinyl and acrylic resins, but it was known that their manufacture in 1939 had been double that of 1938. It had been known also that the production of polystyrol resins in the U.S.A. by 1939 was around 2,000 tons.

Special emphasis should be given to the concentration of attention shown recently in the U.S.A., as well as in other countries, to a new field of the organic synthesis of the aliphatic series, namely, the production of substitutes for natural rubber and textile fabrics. Thus, not long before the outbreak of the present war plans were well advanced for organizing in the U.S.A. the manufacture of synthetic rubber of the "buna" type, utilizing butane as the raw material for obtaining butadiene.

Side by side with the production of the established American commodity "Duprene" (made out of chlorprene, which is prepared from acetylene and hydrochloric acid), as well as neoprene and "Thiokol" (synthesized from ethylenedichloride), in 1939 the Goodrich Co. marketed a novel rubber substitute under the trade name "Vistanex," which is a derivative of polyisobutylene.

Synthetic Fibres as a Major Industry

The manufacture of artificial fibres in the U.S.A. by 1939 amounted to about 175,000 tons, including in this figure the acetate silk of about 50,000 tons. Lately there has been produced a series of new synthetic resin fibres, comprising such already widely known (since 1939) commodities as "Vinyon"—derived from chlorvinyl and vinylacetate, and nylon—derivative of polyamid resinoids, i.e., of dicarbonic acids and polymethylenediamines, and also fibres derived from the chlorvinylidene.

The new fibre nylon is superior to natural silk in many respects: it can be produced at lower cost and may be spun into fine filaments stronger than the natural product and, among other applications, is suitable for making parachutes, medical dressing materials, etc. The first nylon works in the U.S.A. was put in operation by the firm of Du Pont at the end of 1939; by 1940 there were two more factories under construction and the beginning of production in Great Britain and Italy, with the intensive research on the manufacturing methods in Germany.

Furthermore, quite recently there have been derived novel fibres, namely, "Duraclad"—acid-proof fabric (of unknown composition) for industrial use, and the elastic fibres obtained from high molecular polyisobutylene by the Standard Oil Development Co. for textile manufacture, as well as another resinoid fibre, "Etorayon," produced by the Daw Chemical Co. as a substitute for silk in knitted goods, also "Newresinol" and "Santoresin," being the products of co-polymerization of olefine and diolefine hydrocarbons.

The foregoing examples amply illustrate the intensive development of organic synthesis in America and its significance for a great number of arts and crafts, whose progress from a certain point is intimately bound up with the advance of the synthesis of the aliphatic series.

(The continuation of this section of Mr. Brajnikoff's article will be published in our next issue.)

THE BOAT WITHOUT A NAIL

(Continued from page 197)

amenable to very quick curvatures the designer is not limited in the scope of his formations.

The company also produces aircraft sections in the same plant and the process is obviously flexible enough to produce a wide range of other structures. It could clearly be employed for the production of much larger boats, complete aircraft, automobile bodies, and even moderate-sized buildings. We look forward to considerable developments in peace-time.

A special word must be said about the phenol-formaldehyde resin glue employed here. It is a completely new type made by Catalin, Ltd., under the trade name of Catacol. It is, so far as we know, the only phenolic resin which is truly cold-setting, all others needing high temperature and pressure to complete the hardening. It can, of course, be used as a semi-hot hardening resin, and is so employed in the Merron processes.

SEEING HOW IT WORKS

(Continued from page 195)

the Catalin one, it can be seen at once that a new field for such plastics has been opened, and we hope that research engineers will take advantage of them. When we consider also that these phenolic resins can withstand the attack of most acids and other chemicals, the field is even wider.

The remaining two photographs of objects also machined from Catalin give a more complete picture of the scope of cast resins. One is a very complicated machining stated to be a gas distributor; the others are more obvious pieces of work—a pump-casting and a gas or liquid stop-cock or regulator. How often have we regretted opacity in a pump or cock when something has gone wrong—a stoppage of flow in a pipe-line—and how much we would give to trace the cause, without dismantling the plant? A piece of grit or dirt seen through a transparent medium would cut down our worries considerably.

Indeed, transparency in engineering might avoid not only trouble, but even danger on occasion. For example, it would be a convenient thing to have the complete draw-off cock of a pure, washed nitro-glycerine storage tank made of transparent plastics. Being non-metallic, it would be safe in itself, and close observation of possible "freezing" in the cock could be maintained. Resins could not be used, of course, in the manufacture of nitro-glycerine, since they do not withstand the attack of oxidizing acids such as nitric acid.

PLASTIC BEARINGS in service

In This, the Concluding Section of the Account, Discussion Centres upon the Performance of Synthetic-resin Bearings in Various Spheres of Utilization

IN the previous issue of "Plastics" the theory and general practice of plastic bearings was considered; some specific examples will now be noted. A crane for 20 tons maximum load and a span of 26 yds. was fully provided with plastic bearings in place of the usual bronze bearings for all wheels and rotating shafts. The specific bearing pressures and speeds as well as the places of application are given in Table 1. After a service of four months the condition of all bearings had, owing to an accident, to be investigated.

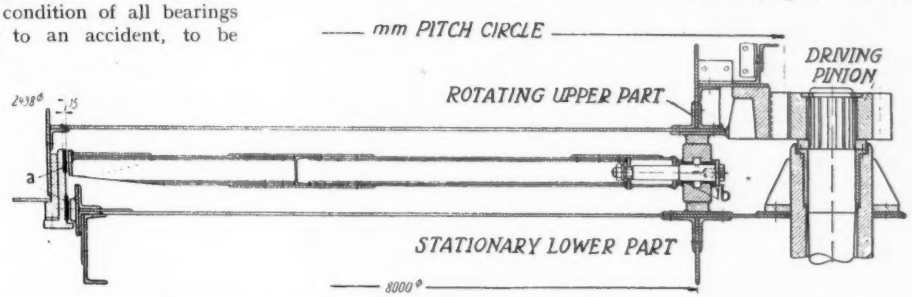


Fig. 5.—Plastic bearings in turntable of chain-type dredger; *a*, double set of 10 plastic segments for turntable guide; *b*, 80 runner rollers on turntable periphery.

Bushes used in driven wheels, and running under highest loads, showed damage of varying degree. The hubs had been fitted with two bushes of $3\frac{7}{16}$-in. and $4\frac{1}{8}$-in. dia. and $4\frac{3}{4}$ in. length, thus resulting in very long bearings being subjected to a one-sided pressure. As a matter of fact, the destruction seems to have been started from the edge, as the bush was heavily carbonized on this spot and showed signs of chipping. All other bushes of laminated material and those on the non-driven wheels were found to be in satisfactory condition when dismantled. However, the wear of wheel shafts was found to be relatively large, i.e., 0.012 in. (0.3 mm.); the steel used was of the usual type, having a Brinell hardness of 192 kg./sq. mm., corresponding to a tensile strength of 44 tons/sq. in.

In the caterpillar frame of a steerable chain-type dredging machine with a continuous lifting capacity of 1,100 cubic yd./hr. (840 cubic m. per hr.) the lifting rollers and pivot shafts of the balancing levers over which the chain ran were equipped with plastic bearings. The main bearing of the turntable which supported the upper part of the dredging machine with a weight of 570 tons was equipped in its upper and lower parts with a set of 10 segments of plastic "a" (Fig. 5) which guide the turntable. The 80 rollers "b" arranged at the periphery were provided with plastic bearing bushes.

The bearing in which the beam of the dredger swung and which performed small movements during operation, consisted of plastics. All components of the dredger which performed swinging movements were in service for 24 hours.

These bearings (materials type T2 and T3) replaced bearings of cast bronze (copper 86 per cent., tin 14 per cent., and copper 85 per cent., tin 9 per cent., zinc 6 per cent.), the shafts were made of a steel of 35 tons/sq. in. tensile strength, in some cases ground in, in others only finish turned. Bearing clearance ranged between 0.01 and 0.02 in. (0.25-0.5 mm.); all bearings were provided with automatic grease lubrication. Service data are compiled in Table 2.

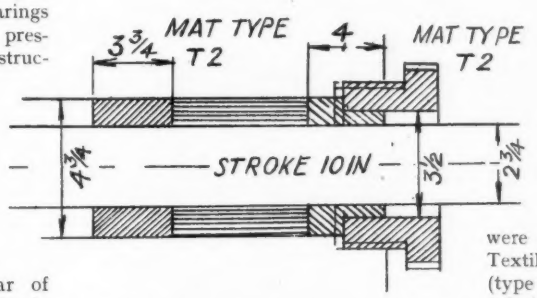


Fig. 6.—Hydraulic pump stuffing box provided with plastic components.

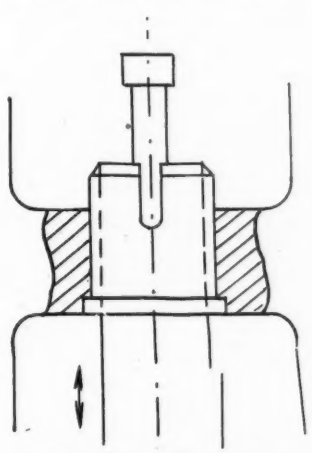


Fig. 7.—Diagram of preforming press, showing the usual sliding bush (see Fig. 8).

In the lignite industry extended tests have been made to introduce water-lubricated plastic bearings in the big presses used for briquette production. Initially the centre bearings and then the two side bearings as well as the ram bearing of a 7-in. press were provided with plastic bearings. Textile chips, irregularly distributed (type T2), have proved to be the most suitable material for shock loads up to 2,850 lb./sq. in. (200 kg./sq. cm.) and speeds of 195 ft./min. (1 m./s.).

The plastic mass was pressed in a steel lining, the contracting surfaces being smoothly machined to give a safe support. A rounded chamfer was provided on both sides to avoid any edge pressure on the shaft. The brass was fixed by two latches under preload with a cross-bearing. After finish machining, the bearings remained in an oilbath of 100 degrees C. to prevent the extrusion of unhardened resin from the brass during running. Owing to swelling effects the liner was bored out 0.08 in. (2 mm.) larger than the shaft diameter. By means of shims, bearing clearance could be adjusted to 0.02 in. (0.5 mm.).

During the first month of service shims of about .055 in. (1.4 mm.) thickness had to be removed. For lubricating purposes uncleaned pit

water, distributed by a wide groove, is used. The water lubricators had been provided with small receptacles through which, before stopping the water supply, oil for rust prevention was supplied to the bearings. The shaft was redressed and pressure polished before use. The press operated about 3,800 working hours with good results; the oil saving was about 600 lb. (270 kg.) during this period.

The two side-bearings of $8\frac{7}{8}$-in. dia. and $9\frac{1}{16}$ in. length were also equipped with plastic linings. The ram bearings of $6\frac{1}{2}$-in. dia. and $10\frac{3}{16}$-in. length were converted too, but in this case a combined lubrication with grease and oil was used. The middle bearings have hitherto run for 6,300 hours, the other bearings 2,700 hours. The cost of the plastic bearings will be recovered in one year by saving in oil alone.

The presses run at a speed of only 80 r.p.m., but it is expected that presses with speeds up to 120 r.p.m. can be safely equipped with plastic bearings, although for these cases lubrication by means of grease-briquettes or water-oil emulsion will be provided.

Electric-motor Problem

Until recently, the application of plastic bearings to electric motors was not successful, in spite of the fact that electrical firms belong to the main producers of plastic bearings. Unfavourable results are attributed to the bad heat conductivity of the plastic bearings; electric motors generate a high friction heat, and, in uninterrupted service, heat hold-up is caused unless other means for cooling are applied. This, however, does not seem to explain fully the position.

In the case of small hand-driven household machines, the bodies of which are moulded of plastic materials of the phenol-resin or urea-resin type, shafts can be directly placed in the body. Less wear of shaft may be expected, than in the case of machines with cast-iron bodies, whilst friction between shaft and bearing is reduced and no lubrication is necessary.

Plastic Bearings in Pumps

The three white metal bearings for the crankshaft of a low-pressure hydraulic pump of 11.2 cubic ft./min. (320 l/min.) capacity and 1,070 lb./sq. in. (75 at.) pressure, and a service time of eight years, were replaced by bearings of plastic material. The external flywheel bearing is of the split type with coverplate, the other two bearings of three segments are made according to a special design adapted to the purpose in view.

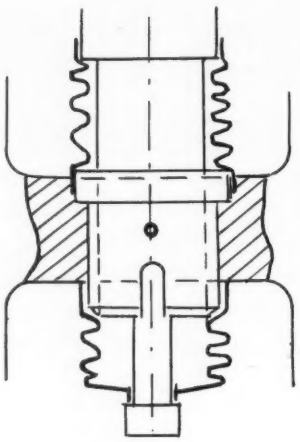


Fig. 8.—Preforming press showing bush of new design in which protection is afforded by leather bellows. (See Fig. 7.)

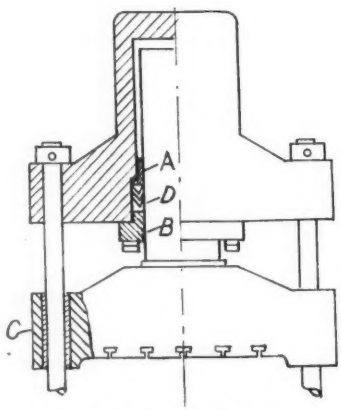


Fig. 9.—Plastic bushes of hydraulic moulding presses: *A*, base bush; *B*, stuffing box; *C*, guide bush; *D*, gland ring.

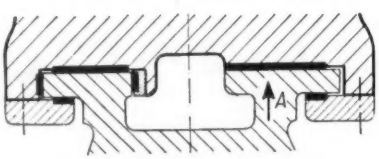


Fig. 10.—Slideway of heavy machine tool equipped with laminated plastics. Slideways of this type have been found to yield excellent service in practice.

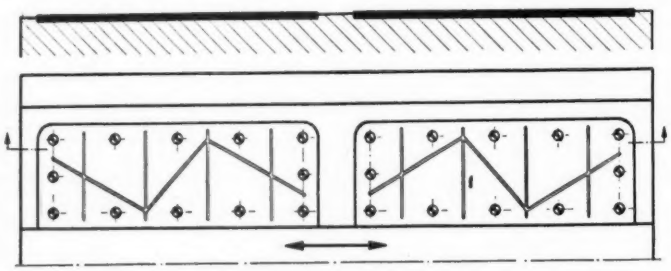


Fig. 11.—Sketch showing method of fixing and oil grooving of laminated plastic sheet for machine-tool slideways.

The first bearing showed satisfactory results during a service time of two years, the second became hot after one hour's service, in spite of increased cooling capacity through increased oil supply, and friction heat could not be successfully dissipated from the bearing. The third bearings of 4-in. dia. and $5\frac{1}{2}$-in. length, running with a surface speed of 1,235 ft./min. (0.63 m./sec.) under a pressure of about 710 lb./sq. in. (50 kg./sq. cm.) showed wear of .024 in. (0.6 mm.) during a service of two years, compared with .04 in. (1 mm.) in one year in the case of white metal bearings. The material used was of the type T2.

Plastic Stuffing Boxes

Satisfactory results have been obtained by equipping low-pressure piston pumps with a stuffing-box of plastic material, of type T2 (Fig. 6). These boxes had been treated for six days in hot oil (90 degrees C.) before assembly. They proved to be absolutely satisfactory during a service time of $2\frac{1}{2}$ years compared with seven months in the case of bushes made of bronze. Maintenance costs could be reduced to about a sixth of the former figure based on experience with metal.

In another instance, relieving rings of bronze had been replaced by rings of plastic material on large centrifugal pumps of a capacity of 165 cubic yd./min. (126 cubic m./min.) and with a speed of 1,465 r.p.m. In the first trial, the stationary bronze ring was replaced by a ring of laminated plastic (woven cotton) running against a steel ring with six oil grooves, but this showed only short durability. When sliding over the grooves the ring swelled owing to the momentary relief from the load, but became compressed again, when the groove was passed. In the next trial a fixed bronze ring and a rotating plastic ring with two ring-shaped and six radial oil grooves was used. After 2,500 service hours the ring was worn off only .00016 in. (0.004 mm.), and after 8,000 hours the total wear was only .006 in. (0.15 mm.). Oil grooves should not have sharp edges. Relieving rings are lubricated only with water, which penetrates sufficiently between the rotating shaft and a fixed bush in the pressure-relieving chamber of the pump.

Plastic Bearings in Preform and Moulding Presses

Some trials will now be discussed which

show how common problems in the plastics industry could be solved by the proper application of plastics as a bearing material.

Automatic pre-form presses usually perform 16-18 strokes/min. and in one instance had to operate for six days per week in three shifts. Tablets of a resin with wood-flour filler had to be made with a tolerance of ½ gm. each and such a consistency was required that when falling from the chute into the transport box and further during the transport and extended handling they should not be allowed to chip and lose weight or become unsuitable in another way.

The main points which determine the accuracy of these machines are the guide bushes of the ram; they should operate, if possible, without any clearance; "edging" (owing to excessive clearance) leads to a quick wear of the die.

Table 1.—Specific bearing pressures and rubbing speeds of plastic bushes for an overhead crane of 20 tons capacity and a span of 26 yards.

	Specific pressure		Rubbing speed	
	kg./sq. cm.	lb./sq. in.	m./sec.	ft./min.
Bush for wheel hub	80	1,140	0.31	61
Countershaft for crane-carrier (bush with pinion)	16.8	240	0.465	91.5
Trolley (bush for wheel hub)	58.5	837	0.155	30.5
Other bushes	2	28.6	0.51	100
	47	675	0.042	8.3
	0.21	3	2	393
	44.3	635	0.18	355
	7.1	102	0.437	86

that a certain amount of press-powder worked between the guide bushes and the ram during pressing, a dust deposit also forming on the old lubricated shaft and, during stroke, being drawn into the bearings, where it accumulates. Thus with each further stroke the friction in the bearings and, therefore, the power-consumption of the machine, increased considerably. These conditions led to a slipping of the driving belt, which quickly wore out and had to be replaced. The bearings ran hot and also the press body became extremely hot (as a matter of fact, temperatures up to 80 degrees C. could be measured).

The press-powder became firmly embedded in the bushes and its action was worse than that of a mere abrasive; it led to an expanding and cracking of the lower end of the bush, as the high temperature caused a melting and semi-hardening of the powder. In the case of bronze bushes the hardened mass caused deep cavities and scoring of both shaft and bush. In this case, the advantage of the plastic mass is the absolute undamaged state of the ram when the bush was worn out, whereas the ram in the case of bronze bushes had to be reground by .04—.08 in. (1 to 2 mm.).

Oil lubrication, however, proved to be a disadvantage in both cases. With increasing bearing heat, the oil ran quicker downwards and was not prevented from mixing with the press-powder. When the machine had to be oiled, pre-forming operations had to be stopped and surplus oil removed. Even after restarting the machine, the ram had to be cleaned from oil, which did not prevent a large number of pre-forms being spoiled.

For these reasons, the design of bushes was changed and they were protected by leather bellows (Fig. 8) which made them grease and dust proof. Instead of oil lubrication, grease lubrication under pressure was applied. Grease is distributed by a ring groove of about ⅛ in. (3 mm.) depth and about ¼ in. (6 mm.) width. The bushes in material T2 were placed in the rough-bored state in an oil bath at 80-90 degrees C. and later finish bored. The first bushes of this kind ran for 11 months without any trouble. The bearing temperature remained nearly at room temperature. It was found necessary to dismantle the ram once every year to relieve the bushes from gummed oil, and to renew the grease.

The changing of crankshaft bearings to those of plastic material did not cause any difficulties. Material was type T2, but with only one fixed collar. The life of bronze bushes was three to five years, the plastic bearings

Table 2.—Service Data for Dredger Bearings.

	Shaft dia.; ins.	Bearing length; ins.	Ratio; length/dia.	Spec. bearing pressure		Rubbing speed	
				kg./sq. cm.	lb./sq. in.	m./sec.	ft./min.
Roller for upper chain side	5⅛	4⅜	0.85	50	710	0.1	19.6
Pivot for balance lever	5⅛	5½	1.07	200	2,850	0	0
Main bearing for turntable	8 ft.	4	—	11 (16)[1]	157 (228)[1]	0.15	29.5
Roller for turntable	2⅜	2⅜	0.86	55	785	0.02	4.0
Swinging bearing for beam	12 7/16	14 3/16	1.15	55	785	0	0

(1) When not operating.

Table 3.—Service Data in Hydraulic Presses Equipped with Plastic Bushes.

Press No.	End pressure of press	Service time, months	Cause of breakdown
1	25	13	Crack in press plate
2	35	11	Piston seizes at gland ring
3	35	14	Still in use
4	35	27	Still in use
5	40	19	Same as No. 2
6	40	16	Same as No. 2
7	40	20	Same as No. 2
8	200	11	Piston covering of V2A detached, owing to seizing of the piston
9	200	12	

Therefore, trials were carried out to replace these bushes by those of plastic material (Figs. 7 and 8); further, the crankshaft bearing and the bushes for the driving pulley were replaced by those of plastic material. The guiding bushes of plastic material received the same dimensions as the bronze bushes, and the same kind of lubrication as used before. The ram of 3⅛-in. (80 mm.) dia. and consisting of a 35-ton steel was smoothly turned so that it gave a running fit in a bush of material type T3 machined out of a tube or pressed, or of material according to type T2.

These bushes lasted only three to four months compared with 12 to 15 months in the case of bronze bushes, but the wear in the latter case was then already so high that they should have been replaced after eight-nine months. The reason for failure was

Table 4.—Comparison Between Bronze and Plastic Bushes for Hydraulic Presses.

	Bronze			Plastic			Ratio of costs
	Weight of blank (lb.)	Weight of finished piece (lb.)	Cost per piece (shillings)	Weight of blank (lb.)	Weight of finished piece (lb.)	Cost per piece (shillings)	
Base bush	35.4	6.92	31/6	3.63	1.17	10	0.32
Guide bush	22.9	4.68	19/6	2.20	0.79	6.9	0.35

giving only 16 months, but being better protected against rust. For the bush of the driving pulley dust protection was provided.

Further trials were carried out to equip the rams of hydraulic moulding presses (with end pressures between 25 and 200 tons) with bushes of plastic material. These presses have been working in three shifts with only short interruptions. They perform 15-25 strokes per hour. The pressure cylinder is rigidly connected with the press body, whereas the piston performed the reciprocating movement.

Wear and Its Causes

Wear of the steel base and steel stuffing boxes, as well as that of the pistons, was very large. The reason for this was the "edging" of the movable cross-head, as well as impurities in the water used. Edging action could not be entirely prevented, particularly where very high and non-symmetrical components had to be moulded. Impurities in the press water formed deposits in the base bush and penetrated between these and the piston. This caused deep ridges or grooves in both piston and base bush, which, on their part, caused a rapid wear of the packing. After a service run of 6 to 10 months the bushes must be replaced and pistons have to be overhauled. Turning of the piston is possible only to a limited degree.

On nine different presses, the base and stuffing boxes for the piston, and the guide bushes for the movable cross-head were replaced by those of the material type (Fig. 9). Pistons were lubricated in the same way as before with regenerated high-temperature cylinder oil and graphite. Experiences with these presses, which have been operating with plastic bushes for two years, are given in Table 3.

Two to threefold durability was realized on two presses which had been in uninterrupted service. Three other presses had to be dismantled owing to other defects. The bronze gland ring was the cause of seizing in the case of four other presses, and an attempt was made to replace this component by plastic material, but, owing to the high stresses, this proved unsuccessful, due to incipient breakdown of the resin surface.

With regard to the trials with guide bushes, no definite opinion could be formed until now, as they have been in use for only 18 months, whereas bronze bushes on these places usually have a durability of 2-2½ years. A comparison of the weight and costs between bronze and plastic bushes reveals interesting facts to those concerned with the economics of substitution (Table 4).

Savings in service are practically a multiple of the initial costs. The plastic bushes require less supervision, and the consumption of stuffing material is less. The maintenance costs of a 35-ton press could be reduced in the ration 1 : 7. Recently plastic bushes have been introduced for withdrawal and ejector plungers and promise to be equally successful.

Slideways of laminated plastics on presses and machine tools have recently been tried out. It seems that the moulders of plastic materials originally conceived this idea by equipping the slideways of their presses with this material. Fried. Krupp formerly used cast-iron bronze for slideways on heavy machines which are now equipped with sheets of laminated plastics. The introduction of bronze plates reduced the wear of slideways, but distinct sensitivity against dust and the risk of seizing remained. Laminated material caused some initial difficulties, i.e., a non-positive motion accompanied by vibrations, owing to the elasticity of the material and the low feed motion, but these troubles have been overcome by an exact scraping of the plates and suitable lubrication.

Strips of 1.1 yd. length of the laminated plastic of woven cotton are exactly placed in grooves of ⅜-in. depth in the slide or pillar base (Figs. 10 and 11). The plates must have an accurate fit on both the bases and the sides in order to be safe against pressure and shear forces; they are held by cheese-head screws, the heads of which should not project and which are driven fast or secured by grub screws. For the adaptation of existing machines, the new plastic surfaces have been brought on to the same level as the original cast iron had. This has been achieved by leaving adjusting blocks on the cast-iron surface, which are removed by machining after the new surface has been brought into position. The plastics surface is provided with ample oil grooves for lubrication, as shown in Fig. 11.

Laminated-plastic Slides

It is stated that large numbers of machines have been provided with such laminated plates during the past two years without any trouble. The wear is very low and the mating bed surfaces of cast iron do not only remain free from seizing, but acquire a mirror-like finish. For the lubrication of surface a special oil (Calypsol) is used.

In a German research laboratory more scientific tests are being carried out to investigate this special application of laminated plastics. An old slotting machine has been equipped with laminated slides and it is tested under speeds between 8.2 to 24.5 ft./min. (2.5 to 7.5 m./min.) and specific pressures between 53-143 lb./sq. in. (3.7 to 10 kg./sq. cm.). Wear tests are carried out with ring-shaped test pieces of laminated plastics pressed against suitably machined and finished metal surfaces.

END PIECE

At a time when British moulding is at a low ebb from the point of view of peace-time manufacture and design, and at high flood from the point of view of war production which we cannot report, it is pleasing to see the type of work to which we shall one day return. Here is a beautifully designed and well-executed book-rack made by the Waterbury Button Co. in U.S.A., from Monsanto's phenolic resin, Resinox. From all reports this type of manufacture is also ceasing in the U.S.A., which is turning over steadily to the production of much sterner stuff. May the change back be even more rapid!